REDD Feasibility Assessment in the Takamanda-Mone Landscape Cameroon

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ARR	Afforestation Reforestation and Revegetation
AUDD	Avoided Unplanned Deforestation and Degradation
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
CARPE	Central African Regional Programme for the Environment
CBFF	Congo Basin Forest Fund
CCB	Climate, Community and Biodiversity Standards
CDM	Clean Development Mechanism
CIFOR	Center for International Forestry Research
COMIFAC	Central African Forest Commission
COP	Conference of Parties
CWCS	Cameroon Wildlife Conservation Society
DBH	Diameter at Breast Height
EO	Earth Observation
EU	European Union
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FMU	Forest Management Unit
FSC	Forest Stewardship Council
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GMES	Global Monitoring for Environmental and Security
GPS	Global Positioning System
GSE FM	GMES Service Element on Forest Monitoring
GIZ	German society for technical cooperation (former GTZ)
IGO	Inter-Governmental Organization
IITA	International Institute of Tropical Agriculture
IPCC	Intergovernmental Panel on Climate Change
IPCC GPG	IPCC Good Practice Guidance
IUCN	International Union for Conservation of Nature
KfW	German development bank
Landsat ETM+	Landsat Enhanced Thematic Mapper
Landsat TM	Landsat Thematic Mapper
LC	Land Cover
LULUCF	Land User, Land Use Change and Forestry
MINADER	Ministry of Agriculture and Rural Development, Cameroon
MINAS	Ministry of Social Affairs, Cameroon
MINATD	Ministry of Territorial Administration and Decentralization, Cameroon
MINDAF	Ministry Of State Property and Land Tenure, Cameroon
MINEE	Ministry Of Energy and Water, Cameroon
MINEP	Ministry of Environment and Nature Protection, Cameroon

MINEPAT	Ministry of the Economy, Planning and Regional Development, Cameroon
MINEPIA	Ministry of Livestock, Fisheries and Animal Industries, Cameroon
MINESUP	Ministry of Higher Education, Cameroon
MINFI	Ministry of Finance, Cameroon
MINFOF	Ministry of Forestry and Wildlife, Cameroon
MINIMIDT	Ministry of Industry, Mines and Technological Development, Cameroon
MINPROFF	Ministry of Women's Empowerment and the Family, Cameroon
MINRESI	Ministry of Scientific Research & Innovation, Cameroon
MMU	Minimum Mapping Unit
MODIS	Moderate-resolution Imaging Spectroradiometer
MRV	Monitoring, Reporting Verification
NDFI	Normalised Difference Fraction Index
NGO	Non-Governmental Organization
NPV	Non-Photosynthetic Vegetation
NTFP	Non-Timber Forest Products
OFAC	Satellite Observatory for the Forests of Central Africa
REDD	Reducing Emissions from Deforestation and Degradation
REDD+	Reducing Emissions from Deforestation and Degradation, Conservation of Existing Carbon Stocks and Enhancement of Carbon Stocks
REL	Reference Emissions Level
REPAR	Parliamentary Network for the Sustainable Management of the Forest Ecosystems of Central Africa
RIL	Reduce Impact Logging
RNSC	REDD National Steering Committee
R-PIN	Readiness Plan Idea Note
R-PP	Readiness Preparation Proposal
SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body for Scientific and Technical Advice
SMA	Spectral Mixture Analysis
SPOT	Satellite for Earth Observation, France
TMLP	Takamanda Mone Landscape Project
TNP	Takamanda National Park
TOU	Technical Operation Unit
TRC	Transformation Reef Cameroon
UNCBD	United Nations Convention on Biological Diversity
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
WCS	Wildlife Conservation Society
WWF	World Wildlife Fund

1 Executive Summary

The following report has been prepared to assess the feasibility of implementing a REDD pilot project in the Takamanda-Mone landscape in southwestern Cameroon. In partnership with the Cameroonian government and the wider donor community, the Wildlife Conservation Society (WCS) started this assessment of the development of a pilot landscape-level approach to REDD in the Takamanda-Mone Landscape Project Technical Operations Unit (TOU) in 2009.

The study examines current and future threats and the potential implementation of different types of emissions reduction activities, as well as reforestation when appropriate, in a spatially coherent way that takes full account of local development needs. The goal of the feasibility assessment is to provide the main stakeholders in the landscape with more detailed information about the current drivers and underlying causes of deforestation and forest degradation and to evaluate options for different land uses including REDD+ activities that contribute to local development, biodiversity conservation, and climate change mitigation. It also aims to provide a summary of what data is available for the region and more generally how to think through feasibility assessment and the steps needed to develop a project. The long-term goal of the Takamanda-Mone REDD+ project is to contribute to the national REDD+ readiness preparation in Cameroon through the enhancement of forest resources conservation, biodiversity protection and sustainable rural development in the Takamanda-Mone Landscape.

The site consists of different land-use zones, including the recently created Takamanda National Park, the Mone River Forest Reserve currently set aside for future productive forestry, the remote Mbulu Mountain forest highlands, several active forest concessions, and different zones of increasingly rapid agricultural expansion. Emblematic of the Gulf of Guinea, the Takamanda-Mone Landscape is an area of high biodiversity with important large mammal species found in the forests of this region including the world's most endangered species of gorilla, the Cross River gorilla (*Gorilla gorilla diehli*).

The Takamanda Mone site is subject to number current drivers of deforestation and degradation and future threats. Current drivers are mainly small-scale agriculture, commercial legal logging, illegal logging, and fuel wood collection. Threats for increased deforestation and degradation are road construction and improvements, extension of commercial logging, commercial agriculture and mining. The study focuses on two main scenarios: Avoided unplanned deforestation along roads and avoided planned degradation from improved forest management. Avoided degradation from illegal logging was also a possibility however due to difficulty of measuring the impact, this scenario was only loosely explored. Although this is a feasibility study, we used general criteria for Verified Carbon Standard (VCS) methodologies to inform our analysis.

Historic deforestation and forest degradation

Forest cover maps for three points in time (1986, 2000 and 2008) were generated for a 325,000 hectare project area and a 1.28 million hectare wider representative reference area in which the project area is nested, in order to calculate the historical rates of deforestation. For the entire reference area including the project area, the analysis shows an increase of almost 400% from an annual rate of 0.11% (1,418 ha) for the 86-00 period to 0.43% (5,481 ha) for the 00-08 period. For the project area, the historic deforestation rate for the 86-00 period is 0.08% (267ha) and 0.25% (806 ha) for the 00-08 period. Of note is the general trend of increasing deforestation, even in areas where the rate is relatively low: For example, annual deforestation in Takamanda National Park increased seven-fold from only 11 ha between 1986 and 2000 to 79 ha from 2000 to 2008.

The main causes for forest degradation in the Takamanda Mone landscape appear to be legal and illegal logging. Legal logging currently only occurs in one active concession (FMU 11004) but concessions are planned to be extended to the much larger Mone Forest Reserve in the near future. The conventional techniques used in these operations lead to an average reduction of carbon stocks in the affected forests of only 7% or about 40 t CO_2-e per hectare. Illegal logging seems to be widespread in the landscape and driven mainly by high demand for forest products in neighbouring Nigeria. However, available data are currently not sufficient to have a clear idea of the carbon impact of these activities.

Baseline analysis

Based on the analysis of historic trends, we developed emission reference levels for different emission sources in the landscape in the baseline or business as usual case. The following emission sources have been analyzed over the entire landscape:

- *Emissions from unplanned deforestation:* We modelled future emissions from unplanned deforestation in the landscape based on historic deforestation rates as well as expected changes in deforestation factors such as the road network, most notably the planned construction of a new road linking Mamfe in the South of the landscape to Akwaya in the North. Estimated baseline emissions amount to about 8 million tons of CO_2-e over a potential 20-year project period.
- *Emissions from planned forest degradation due to legal logging:* We estimated prospective emissions from forest based on already planned concession leases in Mone Forest reserve and other potential areas in the landscape and using data from the GAF-AG study and other studies conducted in Central Africa on the impact of conventional legal logging operations on carbon stocks. Estimated baseline emissions amount to 1.6 million tons CO_2-e over the assumed 20-year project period.
- *Emissions from unplanned forest degradation due to illegal logging:* This emission source could only be evaluated in a qualitative way due to a lack of quantitative data necessary for estimating baseline emissions.

These calculations demonstrate that in absence of specific measures for reducing deforestation and forest degradation in the Takamanda Mone landscape, deforestation and forest degradation would generate at least 450'000 t CO_2-e of greenhouse gas emissions per year.

REDD project options and scenarios

An analysis of drivers of deforestation and degradation in the project area identified that past deforestation and degradation trends are likely to continue into the future, and even increase under certain conditions. Based on the drivers and emissions baseline assessment, we then evaluated the following REDD project options as the most promising:

- *Reducing emissions from unplanned deforestation;* three options: i) increase agricultural productivity; ii) promote community based forest management; and iii) create new and/or extend existing protected areas.
- *Reducing emissions from planned forest degradation;* two options: i) implement improved forest management techniques such as reduced impact logging (RIL) and sylvicultural measures; and ii) convert logged to non-logged forest under protected area or conservation concession status.
- *Reducing emissions from unplanned forest degradation;* two options: i) reinforce law enforcement and vigilance; and ii) engage local communities in forest management and monitoring.

We evaluated the feasibility of each of these REDD options based on socio-economic, political, technical, methodological, and economic factors believed to have an impact on the intensity and the localisation of deforestation and forest degradation activities. Of the project options, the most feasible appears to be avoiding emissions from unplanned deforestation. Degradation options, such as avoided planned degradation from avoided legal logging, could be deemed feasible but depend on political support and value of the generated carbon credits on the market.

Based on the above, three potential project scenarios combining different options to reduce emissions from deforestation and forest degradation have been developed and analyzed regarding their emission reductions potential.

- *Protection scenario:* Activities under this scenario would focus on the creation and sustainable management of a network of existing and future protection areas in the landscape, as well as on law enforcement and agriculture intensification for leakage management. Emission reductions are estimated at about one million t CO_2-e over 20 years.
- *Sustainable use scenario:* This scenario would be focused on fostering sustainable management of forest resources in the landscape by local communities and private operators. Emission reductions are estimated at almost 4 million t CO_2-e over 20 years.
- *Integrated scenario:* This scenario would combine the two previous scenarios and thus focus on protection and sustainable management of all forest resources in the landscape by local communities, NGOs and private operators. Emission reductions are estimated at 5,5 million t CO_2-e over 20 years.

Recommendations

Given uncertainty of offset market for REDD at this stage, the increased interest in scaling up REDD efforts to larger sub-national scales with financial compensation through payments for performance, and the potential for different mitigation activities, we recommend the adoption of a sub-national approach to REDD+ in the landscape that combines participatory land use planning, community consultation, piloting of mitigation activities, with regional MRV. This approach could serve as a national pilot for Cameroon, and strengthen previous work to gazette areas of conservation importance.

The feasibility study concludes that scenario 3 has the biggest potential for reducing emissions from deforestation and forest degradation in the Takamanda Mone Landscape and also appears to be the most feasible approach. The following project components seems to be appropriate to implement that scenario:

1. *Reducing unplanned deforestation:* including collection of relevant data, development of a landscape wide integrated land use strategy and improvement of agricultural production.
2. *Reducing planned and unplanned forest degradation from legal and illegal logging:* including support to implementation of Improved Forest Management and RIL techniques, improvement of forest law enforcement and development of alternative livelihoods.
3. *Enhance biodiversity conservation:* including biodiversity evaluation and High Conservation Value Assessment and setting up of new protected areas.
4. *Support diversification of actors of sustainable forest management and conservation:* including support to delegation of forest management to local managers, support to internal forest zoning and support to development of forest management plans.
5. *Monitoring and outreach:* including development and implementation of monitoring systems, conduction of outreach activities and building of capacities of stakeholders.

2 Introduction

2.1 Forests, Climate Change and REDD

Forests, and especially tropical humid and dry natural forests, play a critical role in the ongoing negotiations and global efforts on mitigating climate change. On one hand, forests stocks hold carbon and sequester more carbon when they grow and can thus mitigate climate change; on the other hand deforestation contributes heavily to the emission of greenhouse gases. It is estimated that about 17% of global greenhouse gas emissions come from deforestation and forest degradation in tropical and subtropical countries (IPCC 2007).[1]

However, the Kyoto protocol, the main tool of the United Nations Framework Convention on Climate Change (UNFCCC), does not include any mechanisms for addressing deforestation and forest degradation. Only industrialized countries have obligations to reduce emissions while emissions from deforestation and forest degradation come essentially from developing countries. Developing countries can only currently contribute to climate change mitigation through the Clean Development Mechanism (CDM) mechanism, which includes some limited forest activities (reforestation and afforestation) that count only as temporary credits.

Avoided deforestation was presented by developing countries as a cost efficient way to curb greenhouse gas emissions, and in 2007 the concept of Reducing Emissions from Deforestation and forest Degradation (REDD) was integrated into the Bali action plan for fighting global climate change. In subsequent conference of parties in Copenhagen and Cancun, the definition of REDD was further elaborated, and now integrates the following aspects as REDD+:

- Reducing emissions from deforestation;
- Reducing emissions from forest degradation;
- Sustainable management of forests;
- Increasing carbon stocks.

However, negotiations continue to be stalled at the UNFCCC level for a post-Kyoto agreement and hence to date there still is no clarity about the design of a future REDD mechanism and its integration in the climate agreement.[2]

Nonetheless, several multilateral (World Bank and UNREDD) and bilateral processes are underway to help countries prepare their participation in a future REDD mechanism. Leading this effort is the Forest Carbon Partnership Facility (FCPF), created right after the COP13 in Bali, in which to date 37 tropical countries are participating to prepare themselves for REDD+. This preparation process is structured into three main phases (cf. figure 1):

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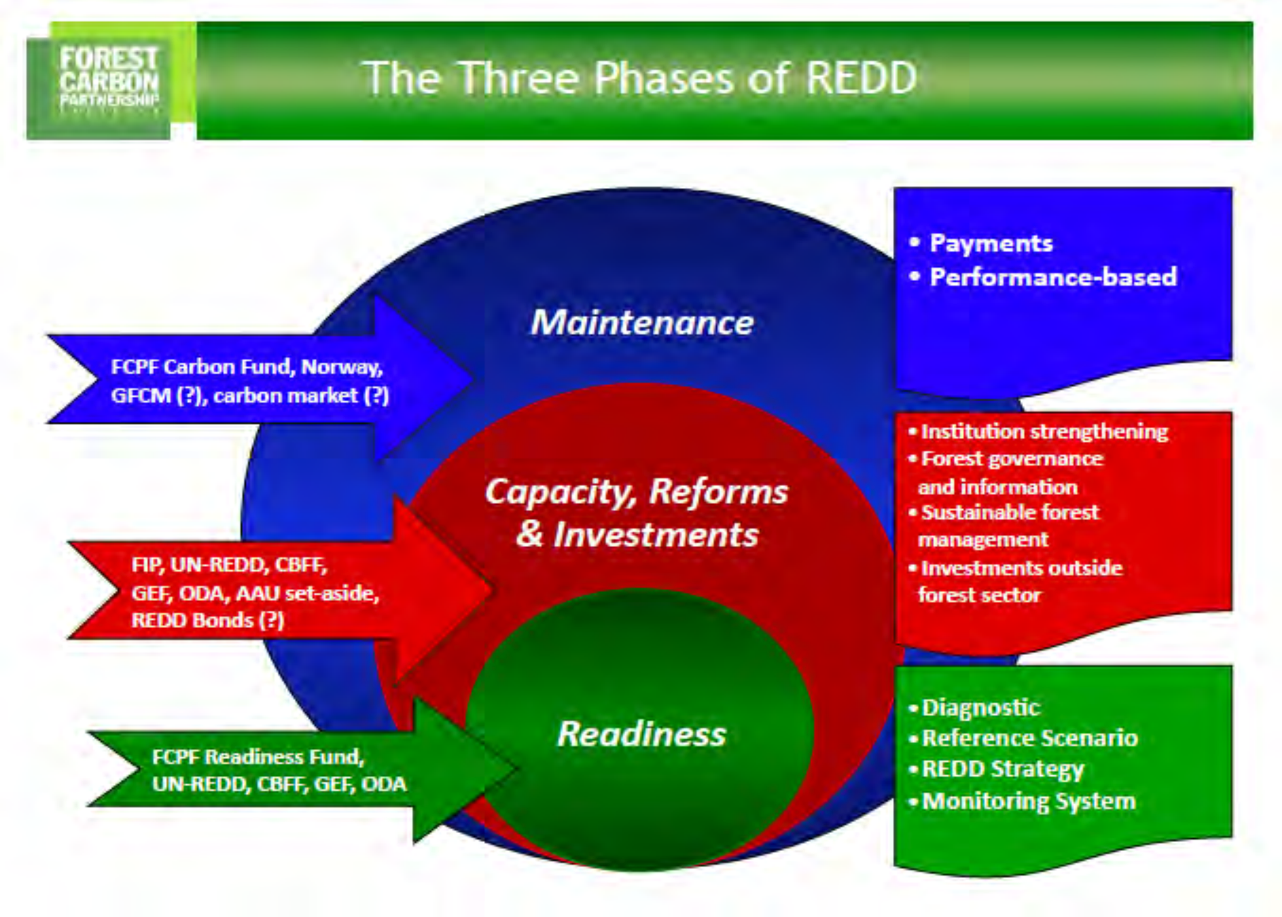
1 Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, Geneva, Switzerland, 2007).

2 At the COP16 in Cancun, several decisions were made and the text reflects consensus about what a future REDD agreement might look like. The text calls for the creation of a REDD mechanism and outline some of the requirements. For example, countries will eventually need to develop national reference levels (RELs) and monitoring systems. Sub-national RELs are allowed both as an interim measure of nested into the national level. This language highlights concern about leakage at a project level, and points to a need in the future to develop accounting and monitoring systems at larger scales. At the recent COP17, a few other issues were clarified. Negotiators agreed that market-based approaches to reduce emissions from deforestation and degradation (REDD) “could be developed” by the annual U.N. climate summit, vague but clear support to allowing market based REDD. IN addition, a technical working group for REDD reaffirmed the fact that countries will submit national RELS, and highlighted that they should be measured in CO2 equivalents not hectares.

Figure 1: The three phases of the FCPF REDD reparation process



- **Readiness phase:** Diagnostic of main drivers of deforestation and forest degradation, development of a national strategy to address these drivers, development of a national emissions reference scenario and of a national system for monitoring, reporting and verification (MRV).
- **Investment phase:** Capacity building and reforms for strengthening institutions, improving forest governance and information, improving sustainable forest management and other related sectors.
- **Implementation phase:** Performance based payments for emission reductions through carbon markets, carbon funds or bilateral arrangements.

Participating countries were selected by the FCPF for support based on a document outlining their ideas for stopping deforestation (known as the Readiness Preparation Idea Notes (R-PIN)). Most of these, including Cameroon, are currently in the REDD+ preparation phase. The first step of this phase is the development of the Readiness Preparation Proposal (R-PP), a roadmap and action plan for national REDD+ readiness preparation.

2.1.1 Introduction to REDD initiatives and projects

REDD+ projects and initiatives complement these national level efforts. The idea for project based REDD emerged as a corollary to the emission reduction projects under the Clean Development Mechanism (CDM). Although they did not qualify under the CDM, carbon credits from these projects could be sold on voluntary markets, where companies or individuals could purchase credits to voluntarily reduce their carbon footprint. Standards and methodologies have been developed to help ensure the rigor of these calculations.

As countries began to develop their national strategies, they often developed official national REDD pilot or demonstration projects. These pilots help inform national REDD readiness strategies by testing out and adapting methodologies on the ground, collecting data, building capacity through on the ground learning by doing and attracting private sector practical. More specifically, these pilots can help test:

- The implementation costs and potential benefits of various strategies to reduce deforestation and forest degradation.
- Legal (carbon property, etc.) and financial (offset transactions, benefit distribution, etc.) aspects of a future REDD implementation framework.
- Techniques and methodologies to develop the baseline scenario for the evolution of carbon emissions without project interventions.
- Techniques and methodologies to develop and implement systems for monitoring, verifying and reporting on carbon emission reductions in the landscape (deforestation, carbon stocks, etc.).

A number of countries distinguish between pilot initiatives and pilot projects by highlighting the market focus of projects:

- **REDD+ pilot initiatives** are interventions that may reduce emissions and inform national strategies through the analysis of historic deforestation and its drivers, the development of methodologies for assessing carbon stocks or systems for monitoring emission reductions, and so on. However, their aim is not to generate and/or sell carbon credits.
- **REDD+ pilot projects** in contrast have the main objective to reduce emissions from deforestation and forest degradation and to sell the generated carbon credits through existing voluntary markets. These projects must thus follow approved voluntary carbon market certification standards such as the Verified Carbon Standard (VCS) or other carbon certifications.

This distinction is mildly useful to highlight different long term funding strategies; however, both initiatives and projects can provide useful data to national processes.

2.1.2 Key aspects of REDD+ projects

Three concepts are essential to understand in the development of REDD projects to demonstrate that the emissions reduced are real and verifiable: 1) additionality; 2) permanence and 3) leakage. They are additionality, permanence and leakage.

- **Additionality** is required to demonstrate that projects will effectively reduce deforestation and degradation and/or enhance forest carbon stocks beyond what would have happened if proposed activities were not implemented.
- **Permanence** refers to the fact that projects or countries will reduce emissions for at least the period designated within the contract.
- **Leakage** refers to the displacement of deforestation or forest degradation activities to another location, resulting in no net benefit of emissions reductions to the atmosphere. Projects and plans must demonstrate that leakage has been accounted for in project or policy design. Measurement, Reporting and Verification (MRV) systems must be designed to monitor leakages and permanence.

These aspects largely define the eligibility of activities as REDD+ projects as well as the methodologies developed for their implementation and thus the different types of REDD+ projects presented in the sections below.

2.1.3 Types of REDD+ projects

Certifications standards have developed criteria and methodologies that can help a project meet these requirements and calculate emission reductions. Most notably the Verified Carbon Standard (VCS) and Climate Community and Biodiversity Alliance (CCBA) provide methodology and guidance on how to measure emission reductions and social and environmental impacts respectively. VCS outlines the technical steps needed to calculate the climate benefit of a project including: calculating the amount of carbon in the forest, developing a baseline based on business as usual scenario, estimating future deforestation, designing activities to reduce forest loss or enhance forest stocks, and monitoring loss over time.

Forestry projects are grouped under the category Agriculture, Forestry and Other Land Uses (AFOLU) projects and can include the following project types that are considered to be relevant in the context of the Takamanda-Mone landscape;

Improved Forest Management (IFM):

Activities increase carbon sequestration and/or reduce GHG emissions on forest lands managed for timber and fuel wood production by increasing biomass carbon stocks through improving forest management practices. Forests must remain forests and extraction activities have to be approved (ie. as logging concessions).

- *Reduced Impact Logging (RIL):* This category includes practices that reduce net GHG emissions by switching from conventional logging to RIL during timber harvesting. Activities can be aimed at: i) reducing damage to trees that are not harvested (directional felling, vine cutting, etc.); ii)
- *Logged to Protected Forest (LtPF):* Activities under this project type aim at converting forests planned for logging into non-logged forests in order to maintain carbon stocks and thus avoid emissions.
- *Extended rotation/cutting cycle (ERA):* This category includes practices that reduce net GHG emissions by extending the period between wood harvesting and/or by increasing the minimum diameter for harvesting.
- *Low Productive to High Productive Forest (LtHP):* This project type includes interventions that aim at increasing the carbon density.

Reducing emissions from Deforestation and forest Degradation (REDD):

Activities eligible under the REDD project type are those that aim to reduce net GHG emissions by reducing or stopping deforestation and/or degradation of forests. Regarding degradation it is important to note that activities aiming at reducing "planned" degradation from legal logging fall under the IFM category. Two types of projects are distinguished:

- *Avoiding Planned Deforestation (APD):* Activities eligible under this project type are those are aimed at stopping or reducing deforestation on forest lands that are legally authorized and documented to be converted to non-forest land,
- *Avoiding Unplanned Deforestation and/or forest degradation (AUD):* This category includes activities intending to stop or reduce deforestation and/or degradation forest degradation that would occur in any forest configuration. Two deforestation configurations are distinguished: i) a mosaic configuration occurs when forests are equally accessible resulting in human

populations, agricultural activities and infrastructure to spread out across the forest landscape; and ii) a frontier configuration occurs when expansion of roads or other infrastructure makes relatively large forest blocks accessible to deforestation agents. In the case of the frontier configuration, projections for future deforestation without project have to be spatially explicit.

2.2 REDD+ in Cameroon

Cameroon has approximately 22.5 million hectares (ha) of forest, mainly situated in the southern part of the country, representing about 48% of all the country's land area of 46.6 million ha (De Wasseige et al, 2009). Of this total forest area roughly three quarters or 16.9 million ha are considered dense forest, while the remaining 5.6 million ha are drier and more open forest formations and woodlands in the north of the country.

Estimates of deforestation in the country vary. A recent study conducted in Central Africa by Duveiller et al. (2008) estimated the annual net deforestation rate in Cameroon between 1990 and 2000 at 0.14% (gross annual deforestation of 0.20% minus gross annual reforestation of 0.06%). This deforestation rate puts Cameroon in second place after DRC in the Congo basin, but this estimate is very different from the FAO figure of an annual rate of 1% per year (FAO, 2007). This difference is mainly due to the fact that the study of Duveiller et al. concentrated on the dense humid forests in the south which are very sparsely populated, while FAO took into consideration all forests and woodlands in the country, including woody savannah and forest-savannah mosaics in the north with much bigger population densities.

Cameroon has been engaged in international negotiations on REDD since 2005 and is an active member of the Central African Forest Commission (COMIFAC) and the Working Group on Climate Change. Within this context Cameroon has contributed to the preparation and communication of five Congo Basin country submissions to the UNFCCC that helped to highlight the role of forest degradation and sustainable forest management in the REDD discussions.

2.2.1 Cameroon National REDD+ Readiness

In 2008, Cameroon successfully submitted a Readiness Programme Idea Note (R-PIN) to the Forest Carbon Partnership Facility (FCPF) and received in 2010 US$200,000 from the World Bank for its Readiness Preparatory Plan (R-PP). Between this time, much of the focus at a national level has been on institutional arrangements.

The Ministry of Environment and Nature Protection (MINEP) and the Ministry of Forest and Wildlife (MINFOF) are the main government stakeholders involved in the REDD process in Cameroon. In 2009 by ministerial decree (0009/MINEP/15 JAN 2009), a national REDD steering committee was set-up. The committee comprised representatives from MINEP, MINFOF, as well as others ministries with activities directly or indirectly related to forest sector, research institutions, Non Governmental organisations, civil society, etc. The committee was also intended to steer the REDD readiness process as well as supervise a REDD pilot led by GAF-AG.(GAF AG, 2011).

After its second meeting in July 2010 at Mbalmayo, the steering committee presented a draft for a new institutional arrangement; a National REDD Coordination Committee would be formed and supported by a National REDD Technical Committee governed by MINEP. The role of the National REDD Coordination Committee has not yet been approved by the Prime Minister.

In June 2011, Cameroon launched its R-PP process. The government's goal is to finalize a draft in January 2012 for review by the FCPF's Participants Committee (PC) at the March 2012 meeting. To meet the FPCP requirements, the Cameroonian government has initiated a consultation process with civil society in order to ensure their free prior and informed consent of the R-PP.

One of the main results of the workshop was a roadmap for developing the R-PP accepted by all stakeholders. Main steps are:

- Regional and local consultations addressed to civil society and indigenous people: June to November 2011
- Elaboration, validation and implementation of the Readiness Preparation Proposal: November to December 2011
- R-PP first draft presentation at COP 17 in Durban, South Africa: December
- Final report submission to FPCF: January 2012

Cameroon is one of the pilot countries whose national level activities are being tracked on the REDD Desk website, a collaborative platform for REDD and REDD Readiness, initiated by the Global Canopy Programme and the Forum on Readiness for REDD, represented by the Brazilian-based Amazon Environmental Research Institute (IPAM). For more in depth information on Cameroon's REDD readiness see the above mentioned web site.

2.2.2 REDD+ pilot activities

Pilot projects may play an important role in the Cameroonian government's national strategy. To date, the Cameroonian government has acknowledged the importance of pilot projects to inform a future national REDD strategy. There is currently no official definition of REDD+ pilot initiatives or pilot projects in Cameroon; however, this distinction will likely be highlighted in the R-PP. Current known REDD initiatives and/or projects in Cameroon are listed in table 1 below.

Table 1: Status of REDD pilot initiatives and projects in Cameroon

Institutions	Title of the activity	Type of activity	Level of implication	Status
GAF AG	REDD Pilot Project Cameroon	Initiative	National	Completed
IUCN	Pro-Poor REDD	Initiative	National	Active
WCS	Piloting a landscape-scale approach to reducing Emissions from Deforestation and Forest Degradation (REDD) in Takamanda-Mone area	Project	Sub-national	Active
WWF	CBSP Conservation and Sustainable Use of the Ngoila-Mintom Forest	Project	Sub-national	Non active
CWCS	CBSP Sustainable Community based Management and Conservation of Mangrove Ecosystem in Cameroon	Project	Sub-national	Non active
GFA Invest	Mount Cameroon REDD Project	Project	Sub-national	Active
CED	Community Payment for Ecosystem Services in Congo Basin	Project	Sub-national	Active
GlobalGreenCorp.	Community Payment for Ecosystem Dja Biosphere Reserve	Project	Sub-national	Active

3 Context

3.1 Concept idea and development of the study

In partnership with the Cameroonian government and the wider donor community, WCS started the development of a pilot landscape-level approach to REDD in the Takamanda-Mone Landscape Project Technical Operations Unit (TOU) in 2009. The area was selected because of its biodiversity conservation benefits, but also the because it was a microcosm of the drivers of deforestation and degradation that face Cameroonian forests in the area and presented an excellent site for evaluating and implementing a landscape-level approach to REDD. Moreover, from an operational perspective, the presence of a strong multi-disciplinary team of government, NGO and private sector partners with long experience of working together (and known collectively as the "Programme for Sustainable Management of Natural Resources in the SW Region of Cameroon") provides a solid foundation for developing a landscape-wide multi-stakeholder project. The existence of an inter-institutional co-ordination mechanism would also permit maximum sharing of experience and process between this site and on-going initiatives, notably the potential Mt Cameroon REDD project and Cameroon's developing national REDD strategy and audit.

In early 2010 during workshop, WCS discussed the possibility of developing this REDD pilot project in the landscape in more detail with MINFOF and MINEP. A concept note was developed based on the discussions and shared with the main stakeholders. After a second scoping mission in mid 2010, concentrated on meetings with stakeholders and collection of existing data on deforestation and forest degradation, WCS secured funding for the feasibility assessment from Spanish LifeWeb/GRASP in September 2010. Additional funding from USAID Translinks program also helped support this assessment.

The expected output of the study was the creation of historical and projected land use change maps for project and reference areas including understanding of drivers of deforestation in the region, as well as the assessment of REDD+ potential of selected management options in the landscape, including a roadmap for the ext steps. When the project was presented to the government in May 2010, the results of the study were to be available by September of the same year in order to contribute to strategic decisions to be made relative to the use of the Mone Forest Reserve. Unfortunately this deadline could not be respected, but we hope nevertheless that the study will contribute to and facilitate the development of management decisions in the area.

The study was developed in the following main steps:

1. First scoping mission in Yaoundé, Douala and Limbé conducted by WCS Cameroon, Congo and Nigeria staff and supported by a GIS and remote sensing specialist from WCS in NY.
2. Initial REDD evaluation mission conducted by an international REDD+ specialist and the WCS Cameroon REDD technical assistant. The mission was concentrated on further analysis of main causes of deforestation and forest degradation in the Takamanda-Mone landscape and discussion with actors on possible scenarios for REDD+.
3. Data collection on carbon stocks in managed and non-managed natural forests in the landscape use of carbon stock proxies for other land cover categories.
4. Analysis of historical and potential future deforestation and other land use changes based on freely available Landsat satellite images from 1986, 2000 and 2010, supported by one ground truthing mission to Mamfe as well as high resolution Quickbird satellite images from 2009.
5. Evaluation of different land use scenarios regarding impact on emissions from deforestation and forest degradation;
6. Discussion with stakeholders on scenarios and report writing.

3.2 General Characteristics

3.2.1 Geography and Land Use

The 12,000 km^2 Takamanda-Mone landscape straddles the border of Cameroon and Nigeria and encompasses an important array of biological and cultural diversity. On the Cameroonian side, the 4,300 km^2 Takamanda-Mone Technical Operations Unit (TOU) consists of different land-use zones, including the recently created Takamanda National Park (TNP) which is situated in the most northern point of Cameroon's South West Region and covers an area of 67,600 ha, the Mone Forest Reserve (MFR) set aside for future productive forestry which lies to the south-east of the national park and covers area of 538 km^2, as well as the remote Mbulu montane forest highlands situated to the east of Takamanda National Park and North of Mone (cf. figure 2). The area includes several active forest concessions and different zones of increasingly rapid agricultural expansion. The following sections describe the designation and management of the main land uses inside the TOU.

3.2.1.1 Takamanda National Park

Before it was designated as Takamanda National Park in 2008, the area was a forest reserve. The Takamanda Forest Reserve was proposed in 1931, constituted by order No 53 of 1934 and published in supplement to Gazette No 44 of 28th August 1934 (Res Reg, DDEF Mamfe).[3] Almost 60 years later, the Takamanda Forest Reserve assumed the management status of a state forest as stipulated under section 24 of law No 94-01 of 20 January 1994 laying down forestry, wildlife and fishery regulations in Cameroon. Under that status, some local subsistence hunting/resource harvesting was permitted, although agricultural activity was prohibited.

The boundary of the reserve was modified following various forestry ordinances as a result of pressure for agricultural land (Gazette No 16 vol3 of 1st August, 1957) and possibly because no concise management option had been adopted. According to this order, in 1957, the Takamanda Forest Reserve had a total land area of about 67,599 ha. On November 21 2008, the reserve was converted into a National Park by Decree Nº 2008/2751/PM. Takamanda National Park now covers a total area of 62,258 ha, of which 57,844 ha (93%) were forested in 2008 (cf. section 5.1.1).

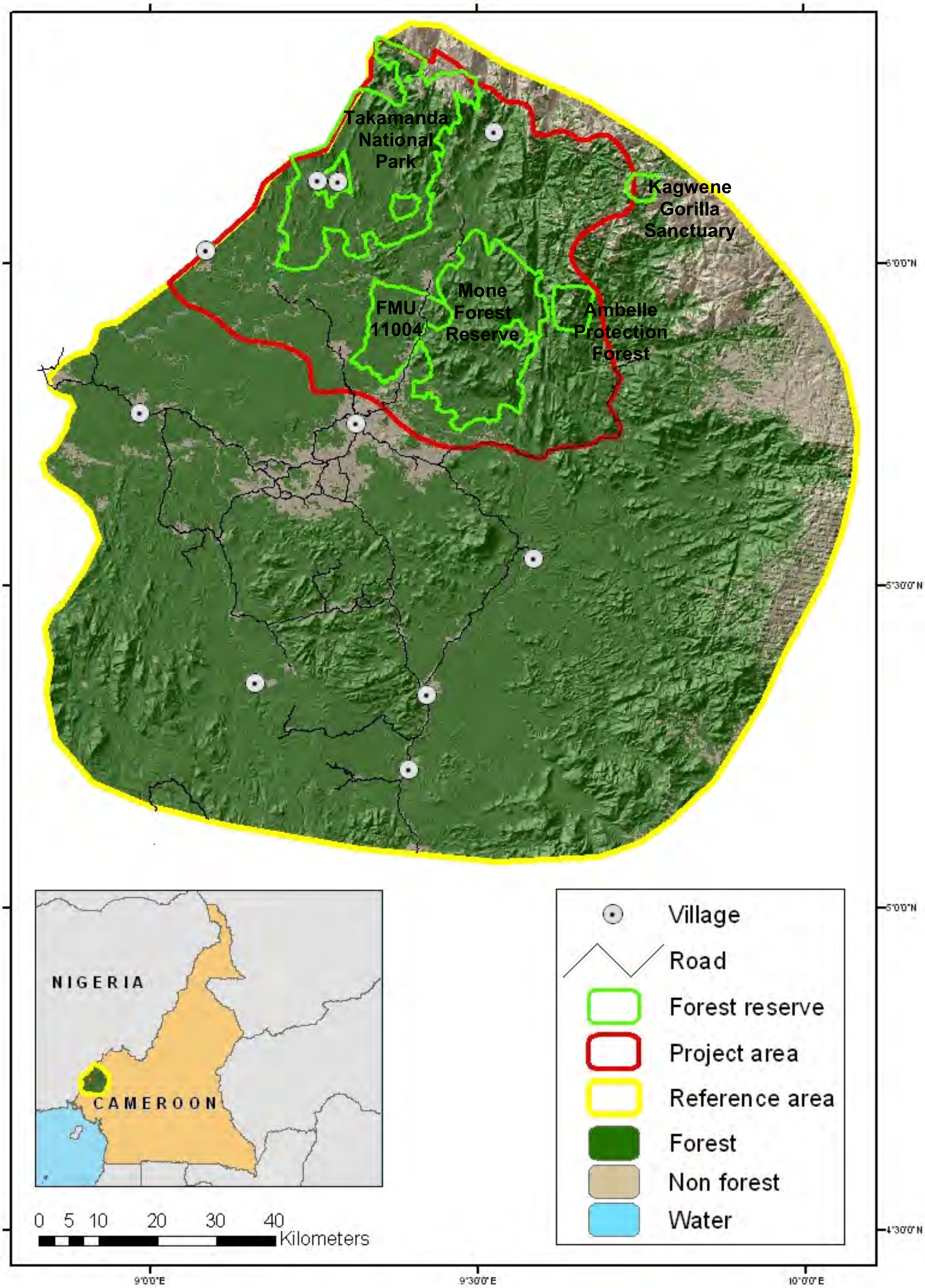
3.2.1.2 Mone Forest Reserve and Mbulu Mountains

The Mone Forest Reserve (MFR) was proposed in 1941 and gazetted as a forest reserve through order published under section 22 in N. A Public Notice No 38 of 1951, Gaz. No 27 of 31/5/51(Res Reg, DDEF, Mamfe). It covers a total area of 45,868 ha of which 45,646 ha (99%) were forested in 2008. Mone Forest Reserve adjoins the Mbulu forest area in its northern part, Takamanda National Park to the west and to the east is the Ambelle protection forest (4,642 ha, 100% forested in 2008). It is separated from the Takamanda National Park by a number of settlements and a newly constructed but not yet completely finished road from Mamfe to Akwaya.

The Mbulu forest area on the other hand stretches from the high humid forest of the south through a mosaic of montane forest to the savannah grasslands of the north. It lies adjacent to the Takamanda National Park and links this part of the forest to the Kagwene hills in the south-western part of the northwest province. The Mbulu Mountains also act as a corridor for the Cross River gorilla from the Kagwene hills, where there is a proposed gorilla sanctuary, to the Cross River National Park in the south-eastern part of Nigeria. The existence of this species of large mammals has been investigated by a number of researchers including, Groves & Maisels (1999) and Groves (2002).

3 In 1931, the area was known as Takamanda Native Authority Forest Reserve.

Figure 2: General map of Takamanda Mone landscape and its wider reference area



3.2.1.3 Logging Concessions

There are currently three active forest concessions in or near the landscape:

- Concession N° 1089 is held by the company Transformation Rift Cameroon (TRC) in collaboration with a small logging company called SEFECAM and harvesting operations started in 2007. It includes UFA 11003 covering 32,455 ha to the south of the landscape and FMU 11004 with 15,233 ha total and 14,555 ha forested area bordering the west of Mone Forest Reserve (cf. figure 2).
- FMU 11005, covering 80,370 ha, is situated further to the south of the landscape in a concession currently held by CAFECO and exploited by WIJMA.
- Concession N° 1086, constituted by FMU 11001 covering 55,385 ha also to the south of the landscape, was awarded also to (TRC) in 2005 and is currently being exploited.

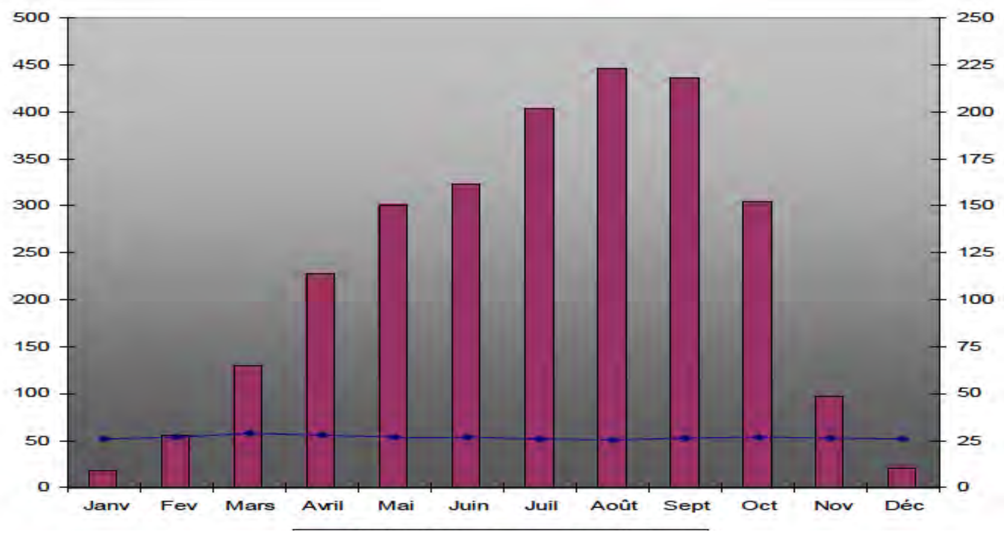
3.2.1.4 Other

Except for the protected areas and concessions, remaining mature forest, degraded and secondary forest is the subject of free exploitation for agriculture and non-timber forest products (NTFPs) by local populations. With an increase in commodity prices, cultivation of cash crops such as cocoa and palm trees is growing. The phenomenon is visible in the south and the western part of the project area, especially around densely populated towns such as Mamfe and Nguti and big villages (Eyumedjock, Bessongabang and Bacho Ntai), as well as along the road between Mamfe and Ekok. The eastern part around Batibo, Fotem and Fongo Tongo are covered by high lands and planted Eucalyptus trees. The few remaining natural forests are found only in some ravines.

3.2.2 Topography and Climate

In general, the southern part of the landscape is made up of lowlands, which lie between 100-400 m a.s.l.. The topography rises sharply to 1500 m altitude in the north of the park where slopes are extremely steep. Small hills, up to 726 m a.s.l., lie to the north of the Obonyi villages along the border with Nigeria. Mone is primarily lowland forest with highland patches occurring from 370-990 m a.s.l. throughout the reserve. Towards the north of Mone and into Mbulu, the topography becomes more diverse from Mount Oko which rises 1250 m a.s.l. The northern and eastern parts of Mbulu towards the Bamenda highlands gradually change from a series of small hills to steep mountains reaching over 2000 m a.s.l.

Figure 3: Temperatures and rainfall in Mamfe



Two main rivers flow through the Takamanda National Park. The Makone River drains the Matene highlands and runs southwest through the park to meet the Munaya River. The Oyi flows from Matene through Nigeria and curves back into Takamanda National Park, acting as part of the western boundary for the Mone Forest Reserve, and eventually drains into the Mamfe River. The Mone river flows through the reserve from east to west, and eventually drains into the Munaya.

The Takamanda-Mone landscape has two distinct seasons: the dry and the wet seasons. Rain starts from mid-March until mid-November. The dry season starts from mid-November and ends in mid-March. The average yearly rainfall ranges from 2,500 to 3,500 mm spread over eight months. The hottest months are from December to February. The mean annual temperature is 23º C with an average maximum of 30º C and a minimum of 21ºC. Temperatures decreases with altitudes. The mean annual relative humidity ranges between 76% and 89% (Ayeni, 2005, figure 3).

3.2.3 Land Cover

The Takamanda-Mone landscape lies at the edge of the transition zone from humid to dry ecosystems. Humid forest ecosystems dominate the terrain. The vast majority of the landscape is covered by dense humid Guinea-Congolian and riverine lowland forest (0 – 500 m), giving way to ridge and mid-elevation forest (500-800 m) in parts of Takamanda National Park and Mone Forest Reserve, with montane forest (800- more than 1500 m) predominating in northern parts of Takamanda National Park.[4] In places where human pressure is higher, the forests tend to be more open and degraded. Towards the North, a mosaic of open forest, shrubland and grassland replaces the dense forests of the Takamanda-Mone Operational Unit (TOU).

The 2008 land cover analysis conducted by GTZ in the Takamanda-Mone TOU classifies land use as follows (based on GTZ 2009):

1. Dense forest: Natural dense humid forests situated in the south and center of the landscape, primarily at low altitude (0-800m), more rarely at mid (800-1,600m) and even high altitude above 1,600m above sea level.
2. Open forest: Natural humid forests degraded probably through logging activities and conversion into agroforests, situated mostly close to agricultural lands at lower altitudes.
3. Shrub savannah: Woodlands located mostly in the north of the landscape.
4. Grassland: Degraded lands located in the north of the landscape.
5. Agriculture-grassland mosaic: In the south and centre of the landscape along roads and near settlements

3.3 Biodiversity

Emblematic of the Gulf of Guinea, the Takamanda-Mone landscape is an area of high biodiversity with important large mammal species found in the forests of this region including the world's most endangered species of gorilla, the Cross River gorilla (*Gorilla gorilla diehli*). Fewer than 250 individuals remain of this elusive Cross River gorilla.

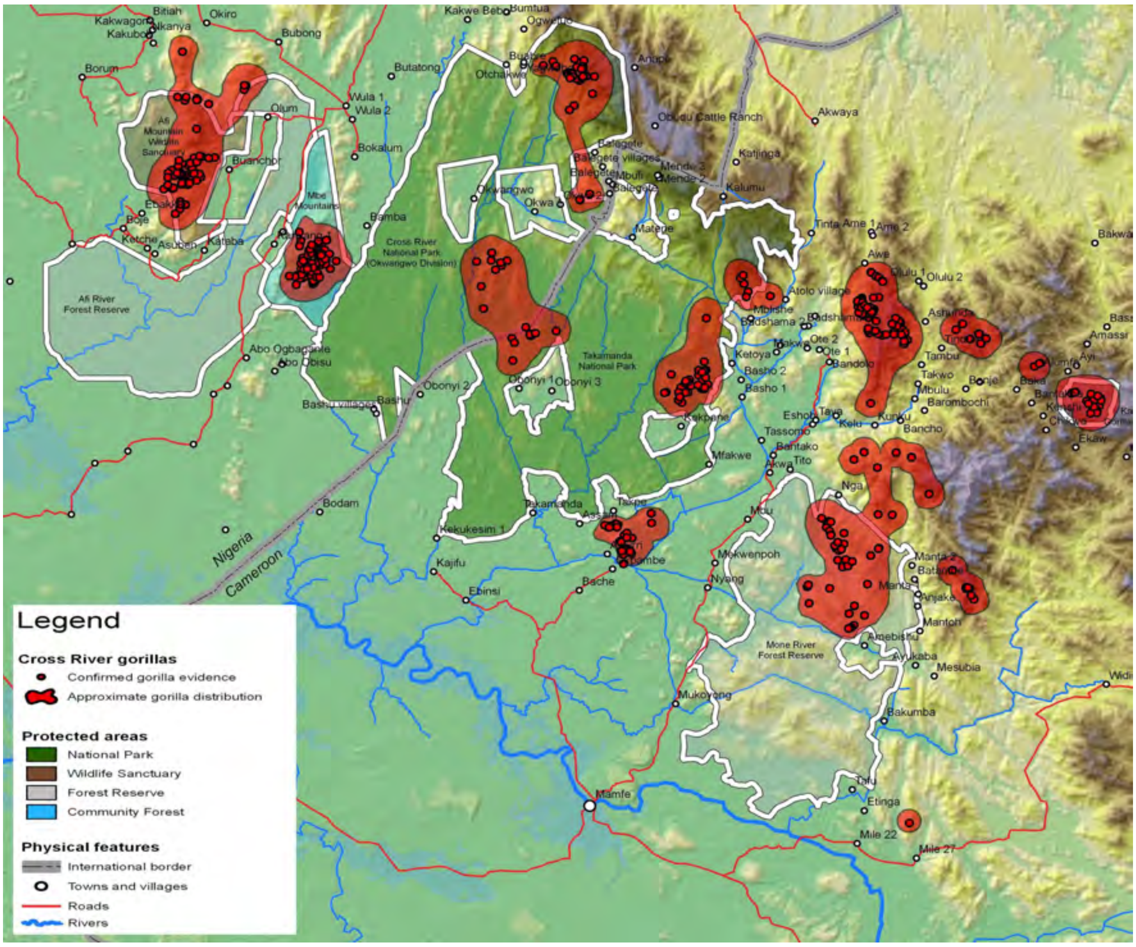
Twenty-five other large mammal species can be found in the forests including a unique sub-species of chimpanzee (*Pan troglodytes ellioti*), the drill (*Mandrillus leucophaeus*), elephant (*Loxodonta african cyclotis*), leopard (*Panthera pardus*) and the Preuss's monkey (*Cercopithecus preussi*). Biodiversity amongst other taxa is equally high, the region has some of the highest levels of plant diversity in Africa and forest cover remains largely intact across the landscape.

4 Sunderland-Groves (2008):

Interestingly, recent surveys show that although under heavy hunting pressure and gazetted for logging, the Mone River Forest Reserve harbours a greater number of species than the adjacent Takamanda National Park including ten possible plant species new to science and the possibility of a new species of hairy frog. In particular, it has been identified as a key area for the protection of the Cross River gorilla, which initially was believed to persist only in a small area in the north of the reserve. Since then genetic and field surveys have revealed that Mone is an hub in a network of unprotected gorilla sites to the east and north, due to its centrality, wide distribution and connectivity with adjacent forests with Cross River gorilla populations (figure 4). The 2007 Action Plan for the Conservation of the Gross River gorilla lists Mone as one of the most important of the twelve known Cross River gorilla sites.

Despite being designated as a biodiversity hotspot of global significance (Myers & al.1999), anthropogenic pressure has led to severe habitat degradation and fragmentation (Bergl, 2006, Sunderland-Groves & al., 2009). While, both ape species are protected by law, much of their habitat is not and will progressively being fragmented by timber exploitation and farming in the area. The livelihood of inbreeding within these small populations is increasing a potentially devastating trend in terms of sustained genetic health and long-term population viability (Bergl & al., 2008). Initiatives to maintain or increase levels of genetic diversity within groups by protecting the ability of these animals to migrate must therefore be a fundamental part of any conservation strategy (Oates & al. 2007; d' Auvergne, 2010).

Figure 4: Distribution of Cross River Gorilla populations in the Takamanda-Mone Landscape



3.4 Socio-economic Characteristics

The socio-economic context in the landscape ranges from extremely intensive agriculture at population densities of over 500 people per km^2 on the Nigerian side to isolated forest-dependent villages, typically of a few hundred people on the Cameroonian side. As access to the landscape on the Cameroonian side of the border is improved, pressures on the forest resources, mainly through rapid expansion of slash and burn agriculture, grassland burning, and illegal exploitation of wood and non-wood forest products, are increasing. Farming can be considered as the most important economic activity in the project area because 31% or the population is involved especially women, except in cocoa plantations (GFA, 2006). Cocoa, palm oil and cassava are the main cash crops in the project area, although rice, plantain and maize are also common.

Gathering of NTFPs especially *Irvingea spp.* commonly named "bush mango", edible greens as *Gnetum sp*., fuel, fodder, green manure, fibre, sticks, medicinal products, seeds, mushrooms, ornamental species and resins generates more cash income. The total income gathered from these products represents on average 290 euros per annum for each household (or 39% of the total household income) (Sunderland et al, 2002). Moreover, Mdaihli et al (2002) reveal that some 470 Million FCFA (714,180 euros) was generated in 2001, aside from the quantities utilized for domestic consumption.

Commercial bush-meat hunting is pervasive and is leading to local extinctions in many forest areas. A total cash value of around 250 million FCFA/year (381,679 Euro) was generated from the sales of bush meat from the TFR region (Ayeni et al, 2003). Some animals, notably the great apes, are still hunted for traditional and medicinal reasons as well. For example, chimpanzee bones are valued for mending broken bones and sprains and snakes are associated with such as the bile and fats of the python (*Python sabae*), which are used to treat rheumatism.

3.4.1 Villages, population, and infrastructure

The Takamanda-Mone and Mbulu area has an estimated population of about 16,000 inhabitants: approximately 12,000 living in 31 villages in and around Takamanda National Park, and approximately 3,200 inhabitants around Mone Forest Reserve and the Mbulu area. Fifty percent or more are between 0 to 20 years old (Asaha, 2005; KfW, 2006). The rapid increase of the population is visible around Eyumedjock area because of the easy access into this part of the region. Additionally most of the villages have basic infrastructure, like hospitals, water supplier and electricity. It is the contrary in the northern part of Mamfe, around Takamanda National Park and Mone Forest Reserve where the situation is precarious. Currently, most of villages inside this area do not have access roads and are only accessible by foot. Populations have no access to safe drinking water, health care and/or sufficient education.

Table 2: Area, population and road network in the South West Region by Division

Division/Region	Area [km^2]	Population in 2001	Total length of road network [km]	Relative length of road network [km/km^2]
Fako	2,060	446,170	422	0.20
Kupe-Muanenguba	3,404	108,211	362	0.11
Lebialem	624	163,534	290	0.46
Manyu	9,565	176,964	597	0.06
Meme	3,105	359,247	561	0.18
Ndian	6,165	107,855	350	0.06
South West Region	24, 918	1,361,981	2, 582	0.10

Source: MINEPAT10, 2001:74 (in GFA, 2006).

The estimated rate of population growth is four percent per year, although this and the other figures are likely out of date and should be revised using the 2005 national census estimates to confirm the growth rate. Considering the high immigration rate coming from the North West region and neighbouring Nigeria, the demographic projections show that the populations will approximately double by the year 2025 putting the area under immense pressure to ensure food security. The population is comprised of a mixed ethnic composition as a result of continued migration. This includes the Anyang people of the Takamanda area, and the Ajoh who occupy the land around Mone with the Kissam, Batieku and Menka.

The infrastructure in the Manyu Division is far below the South West Region average (c.f. table 2). Takamanda-Mone area is an illustration of this with a lack of road connection between villages especially around Takamanda National Park, Mone Forest Reserve and Akwaya. The area is easily accessible via a seasonal road, which links Mamfe to Nyang. During the rainy season vehicles cannot pass the Mone River at Nyang due to lack of a bridge over this river. The road which presently terminates at about 3 km after Bachama is only accessible by four-wheel drive vehicles or motor bike .

Now there is an ongoing project, which aims to tar a national road linking Bamenda to Ekok up to the border between Nigeria and Cameroon. Also, a proposal has been put forth to upgrade the seasonal road from Mamfe to Akwaya. This new road and the improvement will have profound impact on the livelihoods of the population, as well as on emissions, and thus both improvements are included in our model.

3.4.2 Land Use and Resources Management

The state is the primary institution responsible for forest management in Cameroon, as it defines policies for the forestry sector, and grants use rights. In 1994 a reformed legal framework for environmental management was enacted and completed in 1996 by a series of enforcement actions that define the access to forest resources, including customary rights to traditional users, sustainable use, taxation, protection and management of fauna and flora, and the institutional framework.

Table 3: Status of forests in the Takamanda-Mone landscape and wider reference area

Domain	Status	Description	Areas in Project and Reference Area
Permanent Forest Domain	State Forests	Areas protected for wildlife conservation	Takamanda National Park
		Areas reserved for future production	Mone River Forest Reserve
		Logging concessions (FMU) and annual logging permits (VT)	• FMU 11001 (TRC) • FMU 11003 (TRC) • FMU 11004 (TRC) • FMU 11005 (WIJMA) ◦ VT 11-04-01 (Upper Banyang) ◦ VT 11-04-01 (Mamfe)
	Council Forests	Production forests managed by the communes and logged through permits	Nguti Council Forest (not yet attributed)
Non-Permanent Forest Domain	Community forests	Production forests managed by local communities	-
	Private Forests	Privately owned and managed forests	-

Box 1: Community Based Forest Management in Cameroon

Cameroon's previously legislation on environmental management underwent reform in the mid 1990s, by the passing of two laws: the 1994 Law n° 94/01 of January 20 on Forestry, Wildlife and Fisheries and the 1996 Law n° 96/12 of August 5 on Environmental Protection. One of the main purposes of restructuring the legal framework was to increase its contribution to poverty reduction and rural development and thus included provisions to integrate new local actors into forest management. The main tools of this diversification of actors are the council forests and the community forests.

Council Forests:

Besides the forest legislation, the creation of council forests is also governed by the existing legislation on decentralized forest management. Council forests are forests in the permanent forest domain of a maximum area of 10,000 ha and as such cannot be transformed into other land uses. Management authority and ownership is transferred from the state to the council (commune) and management has to follow the same rules as other forests in the permanent domain like logging concessions. In the context of REDD, the following points are important:

- Only very few council forests have been created to date, and in the reference area of the potential REDD project Takamanda-Mone only one, the Nguti Council Forest, is currently under creation with support from KfW.
- Creation of a council forest appears to be very expensive. While the classificiation is relatively affordable (1.5 to 7 million XAF), the costs for obtaining the land title can be above 100 million XAF. Revenues are difficult to assess but in the case of the Nguti council forest harvesting activities generated about 100 million XAF.

Community Forests:

Following decree n° 95/531 PM of August 23 1995, a community forest is a forest in the non-permanent forest domain with an area not exceeding 5,000 ha that has been subject to a management convention signed between a local community and the forest administration. The management of the forest following the simplified management plan is the responsibility of the local community, assisted technically by the forest administration. The revenues generated by the community forest are managed by the local community and used for social activities and to improve the livelihood of the villagers. Several texts exist defining procedures, as well as management and harvesting modalities and norms.

In the context of REDD, the following points seem important:

- Community forests are attributed principally for harvesting for five years and renewable up to 25 years. Management planning is simplified with less stringent norms.
- Costs for creating a community forest are between 1.5 and 5 million XAF depending mainly on the size while total revenues from harvesting the timber products vary widely from 500,000 to 25 million XAF

The legal framework for national forest management distinguishes between permanent and non-permanent forests. Permanent forests comprise lands that are used solely for forestry and/or as a wildlife habitat. Non-permanent forests comprise forestlands that may be used for other purposes than forestry.

In the Takamanda-Mone landscape, the Takamanda National Park, Mone Forest Reserve, logging concessions and council forests are considered part of the permanent forest domain. In the reference area, there is only one council forest which is attributed to the Nguti council. All other forest lands in the landscape have a non-permanent status (c.f. table 3).

The Takamanda National Park is managed closely with its Nigerian counterpart, the Cross River National Park, and contains many of the important wildlife species such as chimpanzees, drills, forest elephants and others, which move freely between these adjacent protected areas. A transboundary conservation program funded by GIZ and KfW aims to protect the area from poaching, promote eco-tourism, and control and survey of parks corridors (Ayeni, 2005).

A considerable number of people inhabit the Mone boundaries and depend on the area for their day-to-day livelihoods. This use has resulted in a gradual but substantial damage to the forest ecosystem. Since its establishment, no concrete management activity had been carried out apart from occasional inspection of reserve boundaries. Illegal activities, such as the selective timber exploitation, are common in the reserve. Ongoing discussions and studies are made now by MINFOF to clarify Mone status with the option of transforming it to a logging concession.

3.5 Deforestation and Forest Degradation

A variety of land use changes in the Takamanda-Mone landscape currently cause decreases in forest carbon stocks. These can be divided into land use changes leading to deforestation and those leading to forest degradation. We outline these in depth in the following section, highlighting the agents and direct and underlying causes, as well as discussing their potential evolution in the future. Figure 5 summarizes these findings.

3.5.1 Deforestation

As noted in previous sections, forest loss in Takamanda is currently quite low. There are a number of threats of deforestation that could potentially increase in the future with changes in infrastructure and leases.

3.5.1.1 Small-scale agriculture

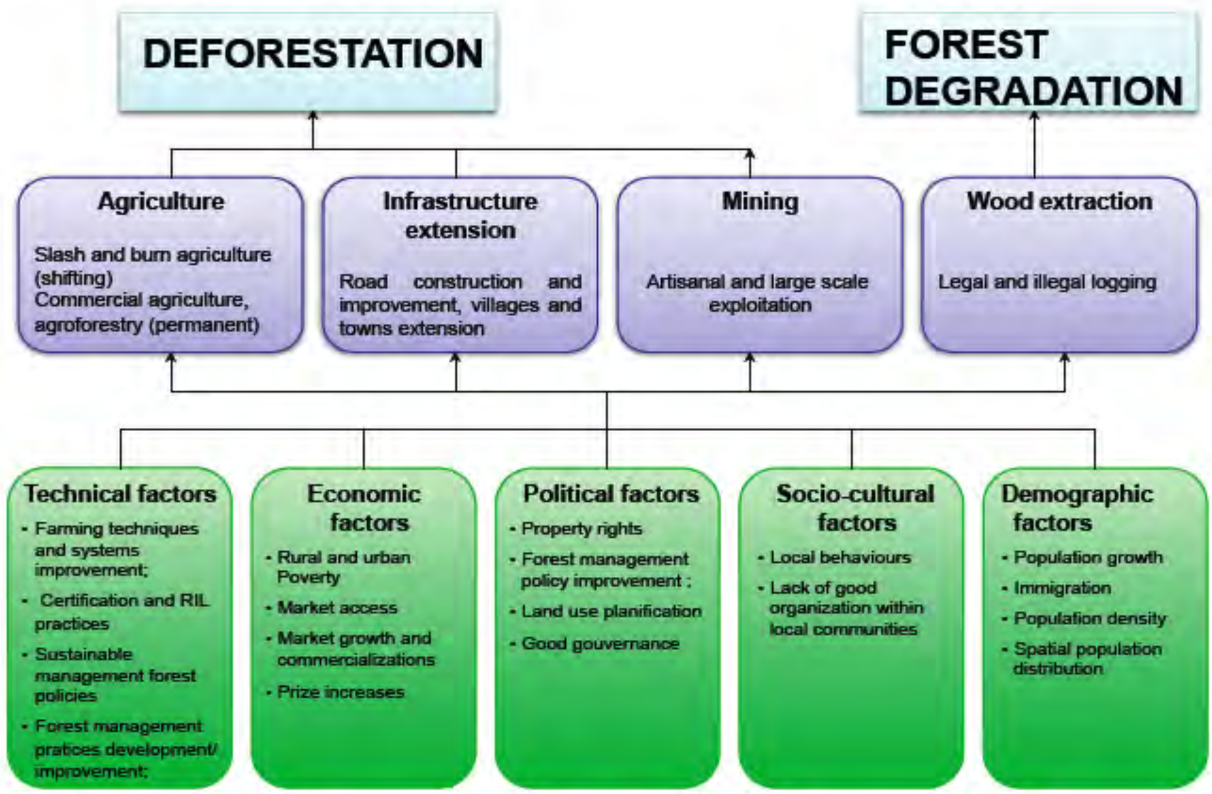
The main driver of deforestation currently is small-scale agricultural production for subsistence consumption and to a limited extent for commercial crops (cocoa especially) occurring around villages. Forest conversion rates seem to be very low, mainly due to low population densities and difficult or non-existent market access. Fertile soils mean that expansion of areas of slash-and-burn subsistence agriculture is limited while there are few incentives for commercial agricultural.

The analysis of historic deforestation between 1986 and 2008 conducted by WCS (cf. section 5.1) has shown that this cause of deforestation has increased and it is very likely that this trend will continue in the future, due to a number of factors including road improvements and population growth.

A small seasonal road in very poor condition that links Mamfe in the south and Akwaya in the north is slated for improvements and upgrade to a secondary (non-paved) road. This appears to be a firm plan and some infrastructure has been put in place over the last years already (e.g. bridge pillars, surface improvements in the southern section). The project to upgrade this road is already financed, although the planning status seems unclear. Ministry of Public Works has planned to link Bamenda to Akwaya first before completing Akwaya-Mamfe. In addition, improvements are planned for the national road linking Nigeria and Cameroon, including the tarring of the passage from Bameda to Ekok to the border of Nigeria and Cameroon.

The completion of these road upgrades would presumably trigger an expansion of small-scale commercial agriculture (different production patterns already exist compared to areas in the vicinity that do not have road access). Depending on market conditions, the main crops could be cocoa, banana, cassava, fruit trees such as *Irvingea spp.*, commonly named “bush mango” and possibly oil

Figure 5: Causes and underlying factors of deforestation and forest degradation in the Takamanda Mone landscape



palm. Avoided unplanned deforestation along the Mamfe-Akwaya road is thus one of the most viable scenarios for the feasibility study and will be modelled. A certain influx of migrants is also possible, although different opinions exist regarding its likely scale - customary rights to the lands along the road and around villages exist and seem to be respected.

Given that soil fertility in the area is good for many years after forest clearing and are better suited to permanent agriculture than those in other areas of Cameroon, development could either result in increased attractiveness for commercial speculations or be spatially limited especially in the case of perennial cultures. For the seasonal cultures, which are the most problematic, some improved agricultural methods are needed to reduce the areas under shifting cultivation due to soil fertility losses.

3.5.1.2 Industrial agriculture

Large-scale industrial agriculture is currently not really an issue in the Takamanda-Mone landscape. However, a proposal and preliminary planning permit (with dubious origins) exists for a large-scale oil palm project south of the landscape. This would concern a maximum of 80,000 ha, although this number is not based on an in-depth analysis of available land areas and economic potential.

For the landscape itself, no such plans exist and no discussions seem ongoing, but it is obviously possible that such a scenario could spring up in the future. For this reason, WCS will remain in regular contact with MINDAF (Ministry for Tenure and Planning), the various Prefectures, and chefs de village as they are likely to first hear of such requests and plans. However, this does not seem to be a very plausible scenario for feasibility study because of the absence of any concrete project development ideas or planning efforts, let alone documentable evidence of the latter.

3.5.1.3 Mining

Current mining activities in the landscape are essentially artisanal and do not seem to contribute to deforestation. There seems however to be a potential for future mining efforts in the area. The company Soft Rock has been granted an exploration permit, although it is unclear which area exactly is covered by this and what types of minerals are hoped for.

At this time mining does not seem to be a plausible REDD scenario given that the timeline and area of potential mining activities are unknown and no documented evidence of a concrete threat can be produced.

3.5.2 Forest Degradation

There are a number of drivers, mainly linked to extraction of wood for different purposes that are currently contributing to forest degradation in the Takamanda-Mone landscape. Their impact, intensity and spatial distribution, as well as potential evolution in the future, are described in the following sections. It however should be noted that the intensity and spatial distribution in particular were difficult to assess in the context of a feasibility assessment.

3.5.2.1 Commercial legal logging

Commercial logging is ongoing in several concessions in the landscape, mainly in the south. The main company TRC is engaged in a process towards certification but not yet in FMU 11004 which is inside the project area. By implementing the Reduced Impact Logging (RIL) practices, they could quantify impact of the improved practices on managed forest compared to their own previous operational practices.

In terms of future degradation, there are ongoing discussions to give out concession areas within Mone Forest Reserve (in accordance with its legal designation as a permanent production forest), which has been found to be important habitat for Cross River Gorillas. Options for Improved Forest Management, set asides, and community forestry will be evaluated in the feasibility study.

Logging is presumably less interesting outside of Mone Forest Reserve and north of the existing concessions because of the difficult topography and also a lower density of commercially attractive species (going towards savannah landscape). There seem to be no such discussions at present, leaving currently only Mone Forest Reserve as a potential site for future extension of logging activities in the landscape.

Forest management standards in the country are very variable and it would need to be established what realistic business as usual (BAU) practices and logging impacts would be for a new concession in the area. The legal standard for Cameroon is quite rigorous but due to low enforcement may not be a good barometer for BAU practices. In principle, it should be possible to find evidence that certain management standards and conservation set-aside area requirements (as in the presence of endangered species) are commonly not respected. Obviously, it may be difficult to document these conditions with ministry or logging representatives. On the other hand, there has been a clear increase in the adoption of more sustainable practices and certification across Cameroon – as demonstrated by above-mentioned example of major operators in the landscape.

3.5.2.2 Illegal Logging

Degradation from illegal logging seems to occur across the landscape, particularly in proximity to rivers. It is especially prevalent around rivers. Illegal removals also seem to occur in the Mone Reserve and the impact on commercially valuable timber species may be significant. It has been reported that local officials of the forestry administration but also village chiefs are implicated in allowing access and granting impunity to loggers who usually come from outside the area.

The actual extent of illegal logging is unclear, both in terms of volume of timber removal and residual damages but also in terms of spatial extent. Natural regeneration of biomass is another unknown. A WCS visual survey on illegal logging exists for some areas. An important factor is the absence of any formal management of the forest area (in practical terms even within Mone Forest Reserve). The trend seems to be an increase in the occurrence of illegal logging, also driven by demand from close-by Nigeria where little exploitable timber volume remains. Nevertheless, the overall impact of illegal logging on carbon stocks in the landscape is probably not important enough to make it a credible scenario for a future REDD project.

3.5.2.3 Fuel Wood Extraction

Residents in the Takamanda Mone landscape definitely use wood for fuel, but the impact on forests seem to be negligible because much of the wood stems from previously cleared slash-and-burn agricultural areas and because population densities are low. There appears to be no charcoal production and no significant export of any wood fuels from the zone, at present. Although it seems likely that fuel wood extraction will increase in the future because of increased population pressure its impact on carbon stocks is probably too low to a plausible REDD scenario.

3.5.2.4 Artisanal mining:

Although quantified data is lacking, current artisanal mining activities seems to have a negligible impact on forest cover and carbon stocks at present.

4 REDD Project Parameters

Two sets of information are critical to calculate potential future emission reductions from REDD projects: land use change and carbon stock data.

- **Land use change data:**

  The land use change (a.k.a. activity) data set includes spatial information on how much and where land use changes occur. This can be historic or future projections of land use change. The historic data set shows areas on which land use changes occurred in different time periods prior to the start of the REDD project and is obtained generally through analysis of remote sensing data. The future data set explains how land use change is expected to evolve with and without the proposed project and is developed through modelling based on information about the main drivers of land use change.

- **Carbon Stock data**:

  Carbon stock data contains quantitative information about the amount of carbon and hence carbon dioxide for different land use classes existing in the area of the project. The data is usually collected by measuring/ sampling biomass in the each of the carbon pools considered by the project. This data then can be used to estimate emission factors that quantify the emissions released by land use changes (i.e. forest to cropland) and are expressed in tonnes of CO_2-equivalents (tCO_2-e) per area of change.

These two sets of information are combined to calculate the total emissions from land use changes in the project area and to estimate potential reductions in emissions from project activities. This is done by comparing emissions in the baseline or business as usual (BAU) case (cf. section 5) with the expected emissions in the with project case (cf. section 6).

The major parameters of any REDD project include 1) types of land use change occurring in the area; 2) the drivers influencing their intensity and evolution; 3) the spatial and temporal boundaries of the envisioned project; and 4) the carbon stocks of the different land uses in the project area. To define these parameters as presented in the sections below, we use general VCS guidelines for AFOLU project development and more specific guidelines of approved and proposed VCS methodologies for the AFOLU project types that seemed to be relevant in the context of the Takamanda-Mone landscape.

4.1 Project Boundaries

4.1.1 Spatial boundaries

A REDD project must identify three main areas of analysis: 1) the project area from which emission reductions are generated; 2) a leakage belt into which deforestation and forest degradation may be displaced because of the project activities; and 3) a reference region from which historical deforestation rates are calculated. The reference region also acts as a control area from which evolving land use dynamics that would have impacted the project area under a business-as-usual scenario can be analyzed. For this reason, the reference region and project area need to be similar in order to guarantee that comparisons are meaningful.

4.1.1.1 Project area

The project area is the main area where project activities to reduce deforestation and degradation will be implemented. At the project start date, the project area must include only forested lands. Any areas that are not forested or have forests that do not conform with the eligibility criteria outlined in the methodology (i.e. areas of planned deforestation in a project applying a methodology for reducing emissions from unplanned deforestation) or additionality criteria (ie. forests in an existing protected area that is well maintained) have to be excluded from the project area.

The project area must include areas that are expected to be deforested but may also include some other forests that are not threatened. Such areas will not generate carbon credits, but they may be included if the project proponent considers that future baseline assessments are likely to indicate that a future deforestation threat will exist in these areas.

As for the present feasibility assessment, the exact REDD project boundaries and activities are not yet known. Hence, we chose to outline a possible project region as the spatial domain in which a future project might intervene. This project region is the area bounded by the red line presented in figure 6, covering a total area of 336,230 ha. All forests inside this zone are considered the project area measuring 315,415 ha in 2008 (cf. table 4). Although there certainly are some issues related to the additionality requirements mentioned in section 2.1.1.2, forests situated inside the Takamanda National Park have been included in the project area and emission reductions in the park will be considered by the feasibility assessment. However, to be included in a future REDD project, it must be demonstrated that the current protection status of Takamanda National Park is not being enforced and REDD mechanisms are essential for protecting these forests against illegal deforestation and/or degradation.

4.1.1.2 Reference Area

The reference area is the analytic domain from which information about rates, agents, drivers and patterns of deforestation and/or forest degradation will be obtained, projected into the future and monitored. As with the project area, the reference area has to entirely forested at the start of the historic reference period (cf. section 4.1.2.1). To make spatial presentation easier, we introduce the reference region as the wider area from which historic information is obtained, including also non-forested lands.

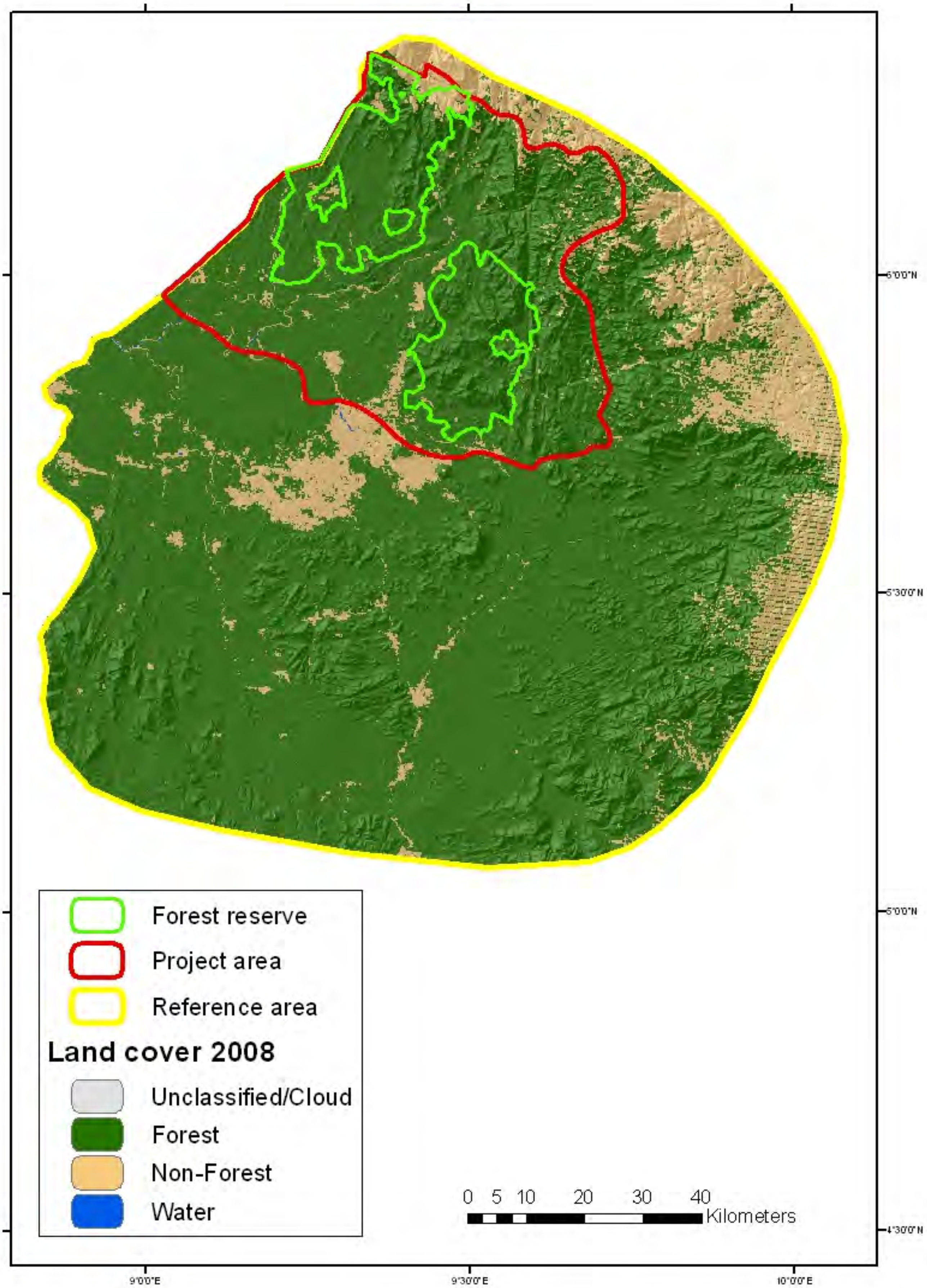
In order to use the reference area to extrapolate changes in the project area, the reference area must have similar agents, drivers and patterns of deforestation and forest degradation to those expected in the REDD project area. Three main criteria are usually used to demonstrate that the conditions in reference and project area are similar:

- **Agents and drivers**, including infrastructure and other spatial drivers of deforestation that are expected to cause deforestation and degradation within the project area in absence of the proposed project activity, must exist or have existed in the reference region.
- **Landscape configuration and ecological conditions** including forest and vegetation classes, elevation, slope, rainfall, etc. must be similar in the reference and project area.
- **Socio-economic and cultural conditions** including legal status of the land, land tenure, land use and resources management patterns, policies and regulations, etc. must be similar in the reference and project area.

Table 4: Proposed spatial boundaries for a potential REDD project

Designation	Forest [ha]	Non-Forest [ha]	Total Area [ha]	Forest Cover
Project Region (2008)	315,415	20.815	336,230	94%
Project Area (2008)	315,415	0	315,415	100%
Reference Region (1986)	1,282,108	152,622	1,434,730	89%
Reference Area (1986)	1,282,108	0	1,218,409	100%

Figure 6: Potential spatial project boundaries used for the feasibility study



Most methodologies tolerate a +/- 10% difference between the application of these criteria in the project and reference area. If the difference is greater than 10%, the reference area has to be changed, although exceptions are sometimes accepted with sufficient justification. The typical size requirements are that the reference area should be three to five times larger than the project area. In most methodologies the reference area includes the project area (as a means to ensure comparability).[5] Analysis of deforestation rates and location of future deforestation must be conducted in the reference area, as in the project area.

Based on these criteria, we selected the area bounded in yellow presented in figure 6 and table 4, including the project area, as our reference region, covering a total area of 1,434,730 ha. All forests in this area at the beginning of the historic reference period in 1986, measuring 1,282,108 ha are considered the reference area for the purposes of the feasibility assessment. The similarities with the reference area have not been checked in detail, and will depend on the project area, interventions and methodology that are ultimately chosen.

4.1.1.3 Leakage Belt

The implementation of activities to reduce deforestation and forest degradation in a certain area can lead to the displacement of deforestation and forest degradation activities to areas outside the project area. As a consequence, most standards require that this leakage be measured and deducted from the emission reductions generated by the project. The leakage belt is the area surrounding or adjacent to the project area where leakage is monitored and accounted for.

We deemed that the delimitation of a leakage belt was not necessary at this time given that it is a feasibility assessment. However we will discuss the risk of leakage in the discussion on proposed REDD options and scenarios (cf. section 6.1-6.2).

4.1.2 Temporal boundaries

The main temporal boundaries of a REDD project are the historic reference period and the project crediting period described in the sections below.

4.1.2.1 Historic reference period

The historic reference period is the period prior to the project start date during which data on deforestation and forest degradation in the project and reference areas will be collected and used to develop the baseline scenario (cf section 5.1). Most approved and proposed methodologies agree that the historic reference period should not start more then 10 to 15 years prior to and end as close to the project start date as possible. In order to allow sufficiently precise projections of deforestation rates and localization of deforestation, it is essential that data on deforestation and forest degradation are available for at least three points in time during the historic reference period.

For the REDD feasibility assessment, the historic reference period is defined by the acquisition dates of the three Landsat satellite images used for analysing the evolution of forest cover in the project and reference areas: 1986, 2000 and 2008. This period spans more than the 15 years mentioned above and in the case of a REDD project additional remote sensing data closer to the project start date will have to be purchased.

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5 One exception, the AD Partners methodology excludes the project area from the reference area and the two areas do not necessarily have to be contiguous. The methodology also introduces a special reference area for localization of deforestation that includes the project area and the leakage belt.

4.1.2.2 Project crediting period

The project crediting period is the period after the project start date during which emission reductions will be monitored and verified to generate carbon credits. The minimum project crediting period for an AFOLU project is 20 years. The project crediting period is not necessarily identical with the duration of the REDD project itself. In order to reduce the risk of non-permanence of emission reductions, the VCS standard requires that REDD activities last longer than the crediting period. If this requirement is not met, then a larger non-permanence buffer is required or in extreme cases the project will not be eligible under the VCS certification system.

For the present feasibility assessment, the minimum project crediting period of 20 years has been chosen and will be applied in sections 5 and 6 for estimating the baseline and project emissions as well as the potential emission reductions of the proposed project.

4.2 Carbon Stocks and Stock Changes

Carbon stocks are calculated by measuring the biomass of different carbon pools in different forest strata. These are used to develop emission factors for different land use changes. In this feasibility study, we look only at two types of land use changes:

1. Deforestation: Forest to non-forest land
2. Forest Degradation: Intact dense forest to logged forest or agroforest

In order to distinguish deforestation from forest degradation it is essential to have a clear definition of forest. As Cameroon has not yet established such a definition, we use the UNFCCC minimum criteria to define forest:

- Minimum area: between 0.5 and 1 ha
- Minimum crown cover: between 10 and 30%
- Minimum height at tree maturity: between 2 and 5 m

If an area of forest does not meet this definition, it will be considered non-forest. For forest degradation, there may be a loss of biomass, but the resulting land cover still fulfils this definition of forest.

4.2.1 Carbon pools

The carbon pools considered in this study based on the requirements of VCS methodologies and biomass data availability are as follows:

- **Above ground tree biomass:**
  Includes living trees with a diameter at breast height (dbh) of 10 cm and above. This is considered to be the main carbon pool and its inclusion is therefore always mandatory. Data for intact forests is available through forest inventories conducted in Takamanda National Park. The following two equations proposed by Chave et al (2005) for moist forests have been applied to estimate biomass:

$$AGB_{est} = \exp(-2{:}977 + \ln(\rho D^2 H)) \quad (1)$$

$$AGB_{est} = \rho \times \exp(-1.499 + 2.148\ln(D) + 0.207(\ln(D)^2 - 0.0281(\ln(D))^3 \quad (2)$$

Where:

AGB_{est}	=	Above Ground Biomass of an individual tree
D	=	Diameter at breast height
H	=	Overall tree height
ρ	=	Wood density, used 0,56 proposed by FAO 1997

The use of Equation 1 results in a lower biomass value than equation 2, and therefore has conservatively been chosen to estimate above ground tree biomass for intact forests for the feasibility study. Results are listed in table 5.

- **Above ground non-tree biomass:**

  Includes living trees with diameter breast height (dbh) below 10 cm and other living vegetation (shrubs, climbers, etc.). This carbon pool is not mandatory but we have included it as it is significant in the landscape. No direct measured data was available on this carbon pool and thus we used the IPCC guidelines, which estimate its value as 6% of the above ground tree biomass (cf. table 5).

- **Below ground tree biomass:**

  Includes roots of living trees with a dbh of 10 cm and more. This is a significant carbon pool and its inclusion is mandatory in most VCS methodologies. No direct measured data on the carbon pool was available for the feasibility assessment and thus we used the default IPCC values of 4% of the above ground tree biomass.

- **Litter and dead wood biomass:**

  Includes tree litter and lying and standing dead wood, both of which are likely significant and included. No direct data available and thus estimated as 5% of above ground tree biomass, based on IPCC guidelines.

Table 5: Carbon stock inventory in dense forests in Takamanda NP (SUNDERLAND 2009)

Plot No	Average dbh [cm]	Average height [m]	Biomass dbh>10cm [Mg/ha]	Non-tree biomass [Mg/ha]	Roots biomass [Mg/ha]	Litter biomass [Mg/ha]	Dead wood biomass [Mg/ha]	Total biomass [Mg/ha]	Carbon [Mg/ha]	CO_2eq. [Mg/ha]
P6	23.5	15.7	308.903	18.534	12.356	15.445	15.445	370.683	176.074	646.193
P7	26.0	15.8	388.879	23.333	15.555	19.444	19.444	466.655	221.661	813.497
P8	20.8	13.9	178.816	10.729	7.153	8.941	8.941	214.579	101.925	374.066
P9	18.9	11.3	96.317	5.779	3.853	4.816	4.816	115.580	54.901	201.486
P10	23.7	14.1	256.670	15.400	10.267	12.834	12.834	308.005	146.302	536.929
P11	21.3	12.5	155.145	9.309	6.206	7.757	7.757	186.174	88.433	324.548
P12	24.7	14.3	277.402	16.644	11.096	13.870	13.870	332.883	158.119	580.297
P13	23.1	14.6	295.685	17.741	11.827	14.784	14.784	354.822	168.541	618.544
P14	26.4	16.3	406.389	24.383	16.256	20.319	20.319	487.667	231.642	850.125
P15	24.9	17.5	325.476	19.529	13.019	16.274	16.274	390.571	185.521	680.863

Statistics:		Total biomass	Carbon	CO_2eq.
	Mean [Mg/ha]:	322.762	153.312	562.655
	Standard deviation [Mg/ha]:	119.919	56.962	209.049
	Variation Coefficient [%]:	37.154	37.154	37.154
	Abs. Standard Error [Mg/ha]:	37.922	18.013	66.107
	Abs. Standard Error [%]:	11.749	11.749	11.749
	Confidence Interval for 95% Prob. (p=0.05; t=2.262) [Mg/ha]:	85.779	40.745	149.534

4.2.2 Vegetation Classification

To increase the accuracy of emission factors, forests are divided into separate strata based on differences in biomass or use. The most important land use classes and estimates of their biomass and carbon stocks are detailed in the following sections and presented in table 8. The following section outlines the analysis conducted to identify these strata.

4.2.2.1 Forest strata

A GIZ-led 2008 mapping exercise described above identifies two major strata of forests: dense forest and open forest. The criteria for this distinction is not very clear, but it can be assumed that the dense forest stratum includes mostly intact forests largely untouched by logging and other deforestation activities, and that the open forest stratum contains mainly forests degraded by legal and informal logging activities and conversion to agroforestry.

For dense forest, carbon stock estimates are based on the mean value of field data collected in the Takamanda National Park (calculated in table 5 & summarized in table 6). Carbon stock estimates for logged forests were more difficult to estimate because the data from logging companies active in concessions in the project area and the reference area is not sufficiently detailed to estimate biomass. Instead we chose to estimate the carbon stock for open forest from logging based on a 2010 GAF-AG study conducted in two concessions in South-East Cameroon (GAF-AG, FAN and Johanneum Research, 2011). For the agroforest stratum, we used IPCC default values for multi-story agroforestry systems, as it is assumed that this stratum is made up of degraded forests with cocoa and coffee plantations in the understory. Below is a more detailed description of the approach and studies in relation to legal logging, illegal logging, and agroforestry.

- **Legal logging:**

  The GAF-AG study analysed the impact of planned, legal selective logging on carbon stocks in two forest concessions in Cameroon: A FSC certified Palisco concession and a non-certified SCBT concession. The 341,708 ha Palisco concession is managed by the French Paquet Group and achieved FSC certification in 2008. The study focused on the 2008 annual harvestable area (AAC) 4-3 covering 4,690 ha in forest management unit (FMU) 10-041. The area in the non-certified SCBT concession was the 2010 AAC 2-2 of 4,833 ha in FMU 1046.

  The study estimated and compared biomass loss due to logging activities in the two concessions. Logging activities included damage to remaining trees during logging and the

Table 6: Biomass, carbon stock and greenhouse gas (GHG) equivalents in different land covers in the Takamanda Mone landscape

Land Cover	Biomass [t/ha]	Carbon+ [t C/ha]	GHG++ [t CO_2-e/ha]
Dense Forest	322.76	153.31	562.66
Logged Forest (non-certified)*	300.00	142.50	522.50
Logged Forest (FSC certified)*	310.00	147.25	539.92
Small-scale agroforest**	250.00	118.75	435.42
Industrial agroforest**	150.00	71.25	261.25
Shrub Savannah**	98.00	46.55	170.68
Grassland**	16.10	7.65	28.04
Post-Defor Agricultural Land**	21.05	10.00	36.67

* Estimates based on inventory data and GAF-AG logging study
** From IPCC AFOLU Guidelines
+ One tonne of biomass contains 0.475 tonnes of C_{12}
++ One tonne of C_{12} corresponds with 3.667 tonnes of CO_2 equivalents

impact of construction of logging roads and skid trails. The results, presented in table 7, indicate that while extraction of biomass through logging is similar (0.78 and 0.75 tonnes of biomass extracted per m^3 (t/m^3) of timber extracted in Palisco and SCBT respectively), logging damages are significantly lower in the certified Palisco concession (1.03 tonnes of damaged biomass per m^3 of timber extracted) than in the non-certified SCBT concession (1.44 tonnes of damaged biomass per m^3 of timber extracted).

Comparison of impacts from the logging road and skid trail construction was not conclusive, but it seems that the impact is similar in the two concessions with a total of 20.98 ha lost in the Palisco concession (corresponding to 0.0045 ha lost per ha logged or 1.46 tonnes of biomass lost per ha logged) and 17.8 ha lost in the SCBT concession (corresponding to 0.0037 ha lost per ha logged or 1.36 tonnes of biomass lost per ha logged). These results are also very interesting because they somewhat contradict the usual assumption that road and trail construction represent the most important impact on carbon stocks from logging.

The results show that total biomass loss due to logging is approximately 37.66 tonnes of biomass per ha in a certified concession, assuming an average of 20 m^3 of timber harvested per ha of dense humid forest. In a non-certified concession the total biomass loss is about 20% higher with 45.16 tonnes of biomass per ha of forest logged. As the total biomass figures in the two concessions (326.12 tonnes per ha in Palisco and 370.42 tonnes per ha in SCBT) are very similar to the values obtained in Takamanda National Park (322.76 tonnes of biomass per ha), it seems acceptable to adapt these figures to the situation in the Takamanda-Mone landscape.

As none of the concessions in the Takamanda-Mone landscape have been certified, this would mean that post-logging forests have a total biomass stock of 277.6 tonnes per ha immediately after logging. However, we know that biomass will increase if forests are left untouched after logging; in fact, logged forests are expected to reach the values of undisturbed forest after one rotation of 20 to 25 years. For this reason, we estimate the average biomass in conventionally logged forest to be 300 tonnes of biomass per ha. This corresponds to an average carbon stock of 142.5 tonnes of carbon per ha (tC/ha) equivalent to 522.5 tonnes of CO_2-e per ha (cf. table 6).

In a FSC certified concession the loss of biomass from logging would be lower and biomass stocks right after logging are estimated at 285.1 t/ha. Under FSC certification, initial biomass stocks would be reconstituted faster than after conventional logging and average biomass in FSC-logged forests is estimated at 310 t/ha, corresponding with a carbon stock of 147.25 tC/ha equivalent to 539.92 tCO_2-e/ha (cf. table 6).

Table 7: Comparison of biomass loss due to logging activities in the certified Palisco concession and the non-certified SCBT concession

Parameter	Palisco [t/ha]	SCBT [t/ha]
t of biomass extracted / m^3 extracted	0.78	0.75
t of biomass damaged / m^3 extracted	1.03	1.44
Total t of biomass lost / m^3 extracted	**1.81**	**2.19**
t of biomass lost / ha of road or trail constructed	326.12	370.42
t of biomass lost by road and trail construction / ha logged	**1.46**	**1.36**
Total t of biomass lost/ ha logged (assuming an average 20 m^3 logged per ha in Cameroon’s humid forests)	**37.66**	**45.16**

- **Illegal logging:**

  Impact of illegal logging on carbon stocks is very difficult to assess, mainly because there is no data available on intensity or extent of these illegal activities. However, as they are generally at a small scale and do not include track construction, impact on biomass is expected to be less important than for the formal logging activities described above.

- **Agroforesty:**

  The clearing of forest for small-scale, shade-grown, cash crop plantations like cocoa and coffee is also a source of degradation. This activity occurs mainly close to other agricultural lands used for subsistence crops, especially at times when coffee and cocoa prices are high on local markets. Agroforestry may begin as forest degradation; however, often it leads progressively to complete deforestation, especially when cash crop prices fall and the plantations are converted into lands for subsistence agriculture (cf section 5.2). It is quite difficult to determine an average carbon stocks for agroforestry land, mainly because there are so many different agroforestry systems practiced throughout Africa. For multi-story systems similar to the ones observed in the Takamanda-Mone landscape, above ground biomass values proposed by IPCC range from 116 t/ha (cocoa under gmelina) to more than 300 t/ha (jungle rubber). For this study, an intermediate value of 200 t/ha has been chosen, corresponding with a total biomass (above and below ground) of about 250 t/ha (cf. table 6).

4.2.2.2 Non-forest strata

For non-forest land covers in the landscape no detailed field data was available and default values proposed by the IPCC AFOLU (Agriculture, Forest and other land uses) guidelines have been used for the three land cover classes (cf. table 6).

- **Shrub Savannah:**

  The IPCC AFOLU guidelines propose a default value of 70 t/ha for above ground biomass for shrublands in tropical Africa and a root to shoot ratio of 40%. A total biomass of 98 t/ha has been used for the present study.

- **Grassland:**

  The IPCC AFOLU guidelines propose a default value of 16.1 t/ha for total (above ground and below ground) non-woody biomass for lands converted to grasslands in the tropical moist and wet climate zone. This value has been used for the present study.

- **Crop Land:**

  Total carbon stocks in biomass of perennial croplands in Africa are estimated at 10 tC/ha, corresponding with 21.05 t/ha of biomass.

4.2.3 Emission Factors

Emission factors (usually expressed in tCO_2-e/ha) describe the potential emissions that could occur from changes from one land use to another one. At the same time, emission factors provide an estimate of the potential maximum emission reductions that can be achieved by avoiding deforestation and/or forest degradation. However, this estimate has to take into account also other factors like potential efficiency of the measures to reduce deforestation and forest degradation, leakage or non-permanence risks that are further analysed in sections 6.2 and 6.3 below. Emission factors for land use changes that seem to be relevant in the Takamanda-Mone landscape are presented in table 8.

4.2.3.1 Deforestation

The following forms of land use change qualifying as deforestation can currently be observed in the Takamanda-Mone Landscape:

- **Dense forest to cropland:**
  Conversion of forest land to crop land is the most prominent land use change occurring in the Takamanda-Mone landscape that falls under the deforestation category.

- **Degraded forests and agroforests to cropland:**
  In certain areas, conversion of already degraded forests, essentially through logging and agroforestry for commercial agriculture, to cropland for subsistence agriculture can be observed. This process is mostly linked to the evolution of prices for products from agroforests such as cocoa or coffee on local markets.

Deforestation of intact natural forests for other types of land use, such as forest plantations or large scale industrial agriculture, seems to be much less important and has therefore not been considered in the feasibility study.

4.2.3.2 Forest Degradation

Under this land use change category, the feasibility assessment takes into account the following conversions observed in the landscape:

- **Intact Forest to agroforest:**
  This form of degradation is currently caused mostly by small-scale activities and therefore has a relatively low degradation impact on the affected forests. Larger scale conversion to oil palm, coca or rubber plantations could potentially happen in the future with a much higher emission factor.

Table 8: Emission factors for different land use changes observed in the Takamanda-Mone landscape

Land use change	Category	Emission factor [t CO_2-e/ha]
Forest land to crop land	Deforestation	525.99
Degraded forest and agroforest to crop land	Deforestation	398.75
Intact forest to small-scale agroforest	Forest degradation	127.24
Intact forest to industrial agroforest	Forest degradation	301.41
Intact forest to conventionally logged forest	Forest degradation	40.16
Intact forest to FSC logged forest	Forest degradation	22.74
Intact forest to illegally logged forest	Forest degradation	-
Conventionally logged forest to FSC logged forest	Forest degradation	- 17.42

- **Intact Forest to logged forest:**

  The following types of conversion through logging that are currently ongoing in the Takamanda Mone landscape and could potentially be extended in the future, have been considered by the feasibility study:

  - Conversion of intact forest to conventional legal logging is currently ongoing in one concession in the landscape and could potentially be extended in the future in Mone Forest Reserve.
  - There is no FSC certified concession in the landscape for the moment. However, conversion of intact forest to legal reduced impact logging under FSC certification could potentially occur in the future.
  - Illegal logging seems to occur quite frequently in the landscape but due to a lack of data it was not possible to estimate its impact on forest carbon stocks. Due to the relatively low volumes involved and because of the transformation on the felling site impacts are expected to be lower than from legal harvesting.

- **Conventionally logged Forest to FSC Logged Forest:**

  Forests currently under legal conventional logging could also be transformed into forests under legal reduced impact logging. The emission factor corresponding to this scenario has been estimated based on the results of the GAF-AG study mentioned in section 4.2.2.1. It should be noted, however, that this process leads to a reduction of emissions from forest degradation (compared to the other processes which lead to an increase), which explains the negative emission factor.

5 Baseline Analysis

In order to measure potential emission reductions, a key step is to establish a baseline or Business as Usual (BAU) scenario. The baseline scenario consists of the emissions related to deforestation and/or forest degradation that would have occurred without the REDD project activities.

Development of the baseline scenario is a central element of all existing VCS methodologies. It is usually based on the analysis of historic deforestation, carbon stocks and emission factors, as well as the main drivers of deforestation and forest degradation. The choice of methodology usually depends on the type and configuration of deforestation and/or forest degradation occurring in the project area and has important impact on how the baseline will be developed.

- ***Deforestation type:***

  As mentioned in section 3.3.2, forests in the Takamanda-Mone landscape belong to and fall under the management authority of the state. Existing plans for converting intact forests into large scale industrial plantations are vague and therefore planned deforestation is not considered in the feasibility study. Hence, only unplanned deforestation will be evaluated.

- ***Deforestation Configuration:***

  In the case of unplanned deforestation two major deforestation configurations have to be distinguished in the case of unplanned deforestation:

  - *Frontier configuration* occurs when the expansion of roads or other infrastructure makes relatively large forest blocks accessible to deforestation agents. This configuration implies that certain forests inside the project and reference areas are more likely to be deforested and consequently the models for future deforestation have to be spatially explicit.
  - *Mosaic configuration* occurs when forests are equally accessible. Human populations, agricultural activities and infrastructure are spread out across the forest landscape. In this configuration, the probability of deforestation is similar across the project and reference areas and therefore future deforestation in the project area can be calculated by applying an annual deforestation rate. However, following the most recent VCS AFOLU guidelines, spatial projection of deforestation are not required only if it can be demonstrated that: i) no patch of forest in project areas exceeds 1,000 ha and the forest patches are surrounded by anthropogenically cleared land; or ii) 25 percent or more of the perimeter of the project area is within 120 meters of land that has been anthropogenically deforested within the 10 years prior to the project start date

  The Takamanda-Mone Landscape is still largely forested with the forests forming one single more or less continuous block over the entire landscape. Deforestation occurs mainly on the forest edges and along roads and tracks where accessibility for deforestation agents is relatively easy. This situation falls under the frontier deforestation configuration and therefore means that spatial modelling of future deforestation will be required in order to determine where in unplanned deforestation is most likely to occur in the project area.

- ***Forest Degradation:***

  Forest degradation in the landscape is caused mainly by legal and illegal harvesting of timber, while fuel wood collection seems to be negligible and will therefore not be considered in the baseline. Legal logging operations in forest concessions or potentially under community based forest management systems fall under the VCS's Improved Forest Management (IFM) category. Illegal harvesting of timber is of an unplanned nature and the reduction of this kind of activity falls under the VCS Avoided Unplanned Deforestation category.

For the feasibility study only planned degradation through legal logging has been considered for the baseline because of both the difficulty of measuring and monitoring the impact of illegal logging and because plans for opening the Mone Forest Reserve for logging concessions seem a quite advanced (cf. section 4.1).

Based on these reflections and on available VCS methodologies applicable for this configuration, the following steps have to be followed to develop the baseline scenario:

- Estimation of future areas of annual unplanned deforestation in the reference area based on historic deforestation and potential future evolution without the intervention of the project.
- Development of a credible spatial model for future unplanned deforestation in the project area in the without project case.
- Estimation of future annual areas where planned forest degradation through legal logging would have happened without the intervention of a REDD project.
- Estimation of baseline emissions from both unplanned deforestation and planned forest degradation in the project area.

5.1 Areas of Unplanned Baseline Deforestation in the Reference Area

In order to estimate the areas that are likely to be deforested on an annual basis in the future (herein called annual areas of unplanned deforestation), the observed deforestation during the historic reference period, usually ten to 15 years prior to the project start is usually used. Existing deforestation estimates did not cover the full project area and reference area; hence, we conducted a new analysis of historic deforestation described in the sections below.[6]

5.1.1 Analysis of historic deforestation

Remote sensing data used for this analysis usually should fulfil certain quality requirements regarding resolution. Medium resolution data such as Landsat (30 x 30 m pixels) is sufficient. Further, in order to allow credible projections, remote sensing data for a minimum of three points in time during the historic reference period is required: ideally one point at its beginning, one in the middle and one observation at the end of the reference period.

5.1.1.1 Selection and treatment of remote sensing data

Traditional land cover change analysis techniques use aerial photographs and satellite images taken at multiple times to assess the amount of land cover change between two or more time periods (Lillesand and Kiefer, 1994). These techniques depend on accurate land cover classifications of the remotely sensed images to compare land cover changes over time. Algorithms for conducting land cover change analysis are abundant and include the traditional and widely used post classification comparison(Lu et al., 2007; Sader et al., 2001; Yuan et al., 2005; Hilbert, 2006; Kozak et al., 2007; Coppin et al., 2004), composite analysis (Coppin et al., 2004; Singh, 1989; Pilon et al., 1987), univariate image differencing (Coppin et al., 2004; Lyon et al., 1998; Mukai et al., 1987), and others (see Coppin and others (2004) for a review of land change algorithms).

This study used the post classification comparison method, where multiple dates of satellite images were first classified into land cover images and then compared to assess changes in land cover over time. To begin three dates of Landsat imagery, from 1986, 2000 and 2008, were obtained through the US Geological Survey GLOVIS WEB based data service (glovis.usgs.gov). These images are

6 Dan Slayback 2009. Forest Degradation in Takamanda-Mone National Park and Mone Forest Reserve 1986-2008. Published for CIFOR.

identified as Landsat path 187 row 56 and covered the entire project and reference area, as shown in table 11 and figure 8. For the early dates, 1986 and 2000, Landsat 5 TM images were used. For the 2008 date, two Landsat 7 ETM+ images were obtained, one from 2008 and one from 2009, as it is necessary to use two images in order to eliminate the striping due to the scan line correction failure in the Landsat 7 satellite (cf. table 9 and figure 7).

The first step was to prepare and process the satellite images for use in the classification process. We decided to use a principle components analysis (PCA) to reduce some of the correlation between certain reflectance bands in the Landsat scenes. First, we ran a PCA on band 1, 2, and 3 (the visible bands) of the each image and selected the first principle component from the results. Next we ran a second PCA on bands 5 and 7 (the middle-infrared bands), because they too are typically highly correlated. We then selected the first PCA band from the results. Finally, we selected the raw band 4 (near infrared) as it is not highly correlated to any of the other Landsat bands. This processing resulted in a final layer stack of three bands:

- Layer 1: PC-1 from TM bands 1, 2, and 3
- Layer 2: TM band 4
- Layer 3: PC-1 from TM band 5 and 7.

5.1.1.2 Mapping of land cover and land cover change

Once processed, we used an unsupervised classification method to obtain land cover. This method assigns pixels to one of 60 unique clusters based on the spectral response of the pixel across all spectral bands, using the ISODATA algorithm. Next, we assessed each pixel cluster to determine the predominant land cover type of the pixels within the cluster. The assignment of a predominant land cover type was based on a visual inspection of the location and appearance of the pixels and ancillary data, including a 2008 land cover analysis provided by GIZ. If an original cluster contained a mix of more than one land cover class, it was set aside for further processing. This processing involved running the ISODATA algorithm on the mixed cluster to further break it apart into ten new clusters. These ten clusters were again visually inspected, class trajectories identified and incorporated back into the original scene.

Table 9: Remote sensing data used for historical Land Use/ Land Use Change (LU/LC) Analysis

<table>
<tr><th rowspan="2">Satellite</th><th rowspan="2">Sensor</th><th colspan="2">Resolution</th><th rowspan="2">Coverage (km²)</th><th rowspan="2">Acquisition date (dd/mm/yyyy)</th><th colspan="2">Scene identifier</th></tr>
<tr><th>Spatial</th><th>Spectral</th><th>Path</th><th>Row</th></tr>
<tr><td>Landsat-5</td><td>TM</td><td>30 x 30m</td><td>6 bands</td><td>185km x 172km</td><td>12/12/1986</td><td>187</td><td>56</td></tr>
<tr><td>Landsat-5</td><td>TM</td><td>30 x 30m</td><td>6 bands</td><td>185km x 172km</td><td>10/12/2000</td><td>187</td><td>56</td></tr>
<tr><td>Landsat 7</td><td>ETM+</td><td>30 x 30m</td><td>6 bands</td><td>185km x 172km</td><td>31/01/2008</td><td>187</td><td>56</td></tr>
<tr><td>Landsat 7</td><td>ETM+</td><td>30 x 30m</td><td>6 bands</td><td>185km x 172km</td><td>01/01/2009</td><td>187</td><td>56</td></tr>
</table>

Figure 7: Satellite images from 1986, 2000 and 2008 used for historic deforestation analysis

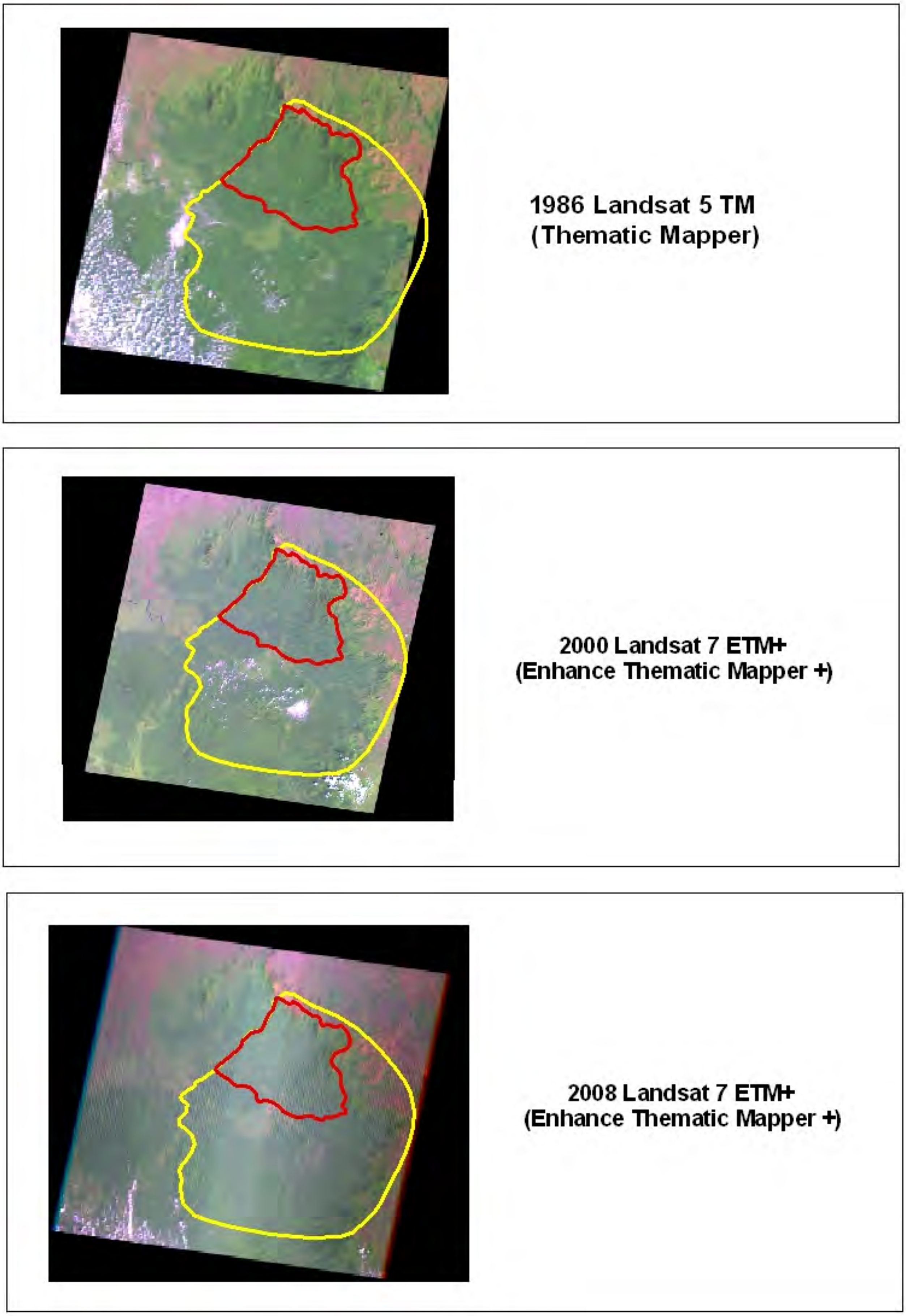
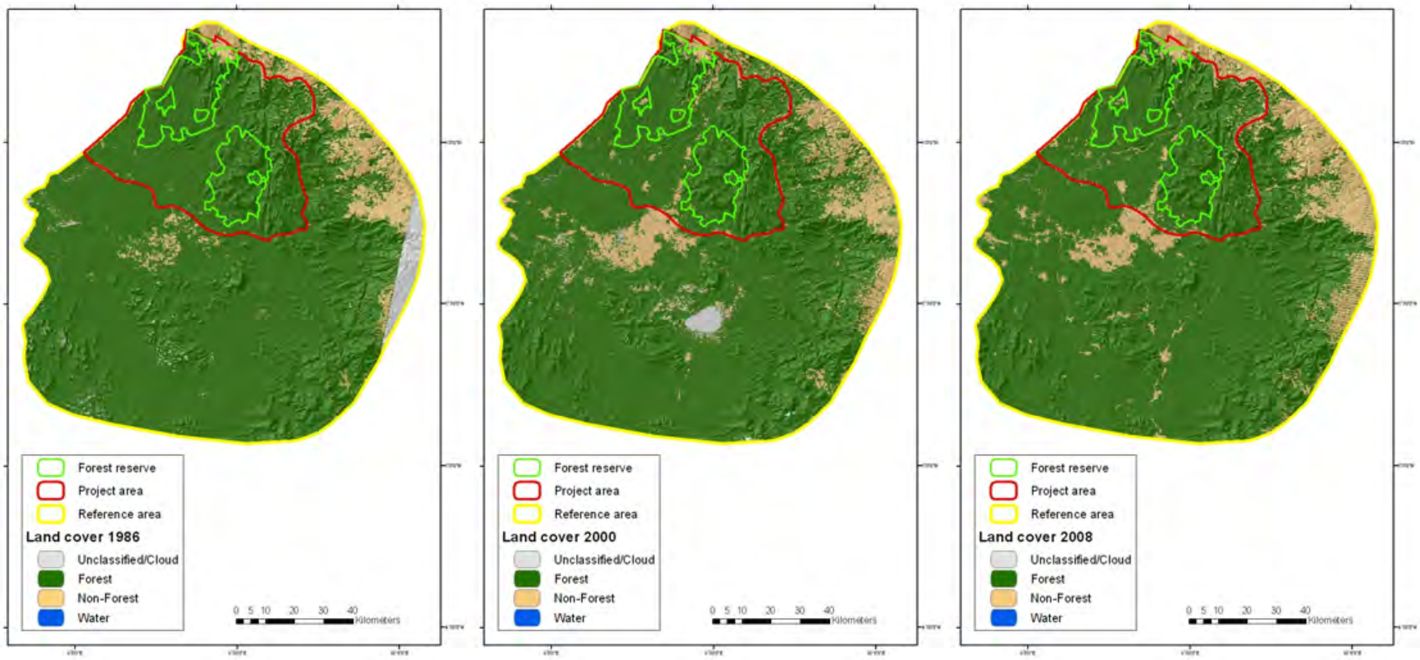
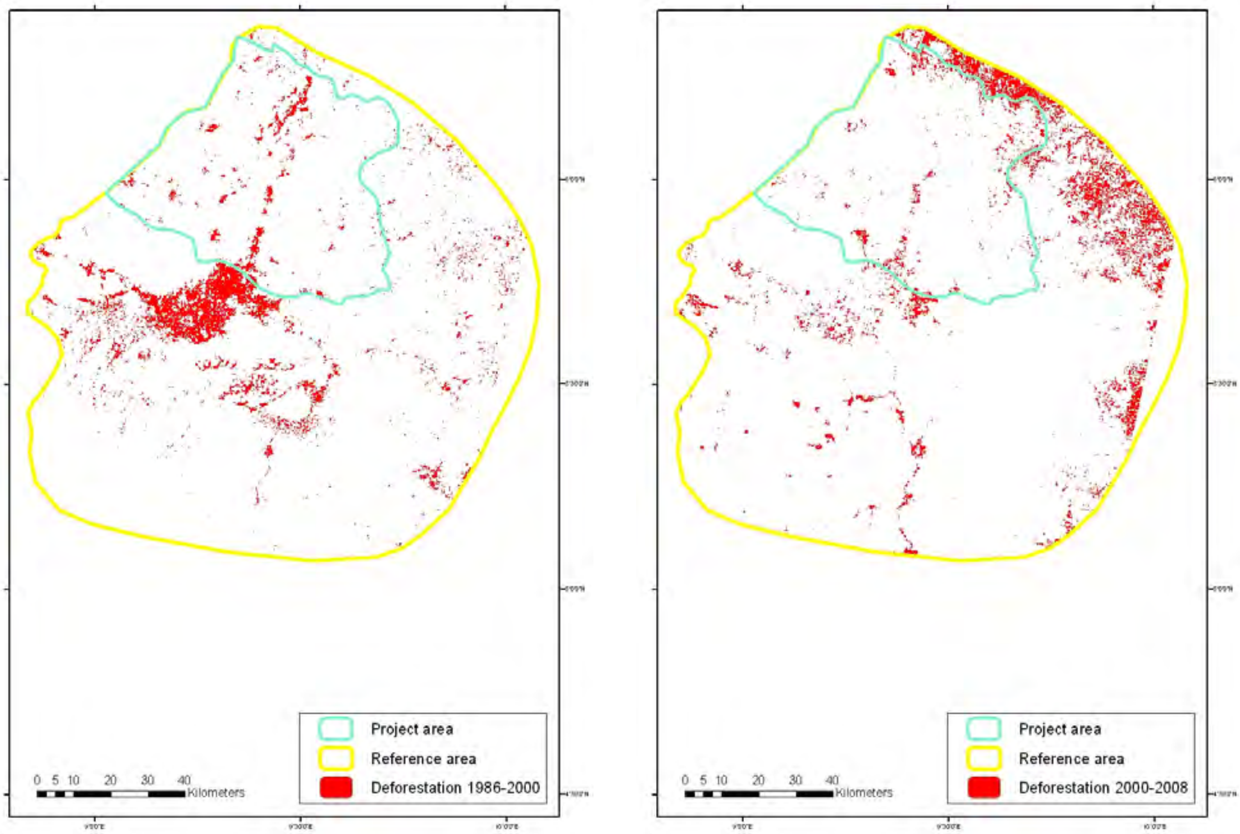


Figure 8: Forest cover maps developed for 1986, 2000 and 2008



Forest 1986 Forest 2000 Forest 2008

Figure 9: Historic deforestation in the reference area for 2 time periods, 1986-2000 and 2000-2008



Deforestation 1986 to 2000 Deforestation 2000 to 2010

This process led to four land cover classifications, one each for 1986 and 2000 and two for the 2008/2009 images. Because of the failure of the scan line corrector on Landsat 7, all post-2003 satellite images suffer from no-data banding or gaps at the edges of the scene. Therefore, we classified two separate images and used the 2009 land cover to fill in the gaps in the 2008 land cover resulting on one final land cover scene representing the most current land cover in the landscape.

Next, the multiple land cover types in each scene were re-classed into three land cover types: forest, non-forest, or water. This was done because of the need to focus mostly on transitions from forest to any other land cover type in order to better model deforestation in the future and to ensure a higher overall classification accuracy. The results of this process are the final land cover maps shown in figure 8 used in the subsequent analysis.

5.1.1.3 Accuracy assessment

As requested by most existing VCS methodologies an accuracy assessment was completed to determine the quality of the land cover analysis. With limited historical data on true land cover types, we focused on an accuracy assessment of the 2008/2009 land cover analysis.

1. 100 random points were generated in areas that showed deforestation from 2000 to 2008. Fifty of these points were then ground truthed to include a target analysis of deforestation in the final accuracy assessment. These field-checked points confirmed that the current land cover type was non-forest.
2. 100 randomly generated points for each land cover type, forest, non-forest and water were checked using high resolution images available through Google Earth. When current images were not available on Google Earth, or the true land cover at a point could not be confirmed, the point was eliminated from the final analysis.
3. These points, combined with the field checked points were run through the accuracy assessment tool called ERRMAT in the IDRISI Taiga software.

The overall classification accuracy for the 2008/2009 land cover image was 88%. Without good ground truth data for the 1986 and 2000 land cover images, we need to assume that the accuracy of the land cover images is at the same level of the 2008/2009 land cover image. This result is slightly below the minimum mapping accuracy of 90% requested by most VCS AFOLU methodologies but is considered acceptable for a feasibility assessment.

5.1.1.4 Assessment of historic deforestation

From the three dates of land cover, we then analyzed land cover changes, specifically deforestation, by comparing land cover over time on a pixel by pixel basis as shown in figure 9. We assessed deforestation at a number of different scales in order to understand how deforestation varies across the landscape with results shown in table 10. Main conclusions from this analysis are the following:

- The entire reference area covers an area of 1,282,108 ha of forest at the beginning of the historic reference period and the project area 315,415 ha at the beginning of the project. For certain REDD methodologies such a reference area would be slightly too small compared with the project area, but for a feasibility assessment it can be considered to be acceptable.
- For all areas considered in table 12, deforestation rates clearly increase over time. For the entire reference area (including the project area), the analysis shows an increase of almost 400% from an annual rate of 0.11% (1,418 ha) for the 86-00 period to 0.43% (5,481 ha) for the 00-08 period. The increase of deforestation appears to be highest in the Takamanda National Park where annual deforestation increased seven-fold from only 11 ha between 1986 and 2000 to 78 ha from 2000 to 2008.

- Deforestation rates are significantly higher in the reference area (without the project area) than in the project area with 0.50% and 0.25% respectively for the 00-08 period. This seems to be consistent with the observation that forests in the project area are currently less accessible than forests further to the south, mainly due to the existing road network.
- In the project area, Mone Forest Reserve had the lowest rate of deforestation (0.01 and 0.02 for the two time periods respectively), followed by Takamanda National Park (0.02 and 0.14%). As Takamanda was only designated a protected area in 2008, its lower accessibility may explain this low rate more than the management status. However, given the seven-fold increase in the deforestation rate from one time period to the next, it seems that the park is becoming vulnerable to increased pressure in the area.
- Deforestation rates are higher along existing roads but only inside the one km buffer (0.39% and 0.60% for the 86-00 and 00-08 time periods respectively) while in the five km buffer deforestation rates are lower than the corresponding mean annual deforestation rates for the reference area. This clearly shows the important impact of increased accessibility on unplanned deforestation in the area and strongly suggests that the planned extension of the road network will indeed lead to increased emissions from deforestation in the project area if no REDD measures are implemented.

Table 10: Historic deforestation in different zones of the Takamanda Mone landscape and its wider reference area

Zone	Forest 1986	Forest 2000	Forest 2008	Deforest. 86-00	Deforest. 00-08	Ann. Def. 86-00		Ann. Def. 00-08	
	[ha]	[ha]	[ha]	[ha]	[ha]	[ha]	[%]	[ha]	[%]
Reference area: (Including project area)	1,282,108	1,262,255	1,218,409	19,853	43,846	1,418	0.11	5,481	0.43
Reference area: (project area excluded)	956,513	940,395	902,994	16,118	37,401	1,151	0.12	4,675	0.50
Project Area:	325,594	321,859	315,415	3,735	6,445	267	0.08	806	0.25
Takamanda National Park	58,633	58,473	57,844	160	629	11	0.02	79	0.14
Mone River Forest Reserve	45,821	45,727	45,661	94	66	7	0.01	8	0.02
Project Area (Takamanda NP excluded)	266,961	263,386	257,571	3,575	5,815	255	0.10	727	0.28
Project Area: (TNP and MFR excluded)	221,140	217,659	211,910	3,481	5,749	249	0.11	719	0.33
Roads and trails: 1 km buffer	255,778	242,192	230,900	13,586	11,291	970	0.39	1,411	0.60
Roads and trails: 5 km buffer	809,319	787,222	767,313	22,097	19,909	1,578	0.20	2,489	0.32

5.1.2 Estimation of unplanned baseline deforestation in the reference area

In order to calculate the annual areas of unplanned deforestation (areas that are likely to be deforested on an annual basis in the future) in the reference area during the project period, the following methods are permitted:

- *Average deforestation:*

  The simplest model for future areas of baseline deforestation is to extend the average annual area of deforestation during the historic reference period into the future. However, most existing methodologies do not allow for this prediction method, unless the other models presented below are not significant and as long as the annual area of unplanned deforestation is higher in the second time period than in the first.

- *Linear model:*

  A linear deforestation model is obtained by fitting linear regression to the mean annual areas of unplanned deforestation for the observed historic time periods. If data from only two periods is available such a regression is always significant, if more points are available the regression can only be used if certain quality criteria are fulfilled.

- *Non-linear model:*

  A non-linear deforestation model is developed by fitting a non-linear regression to the observed areas of annual deforestation in the reference area. Such a model can usually only be used if data is available for at least four time periods and quality requirements are similar to the ones for linear regressions.

- *Modelling:*

  Some methodologies allow for modelling of future annual areas of unplanned deforestation if it can be demonstrated that certain parameters (i.e. population density) have a clear influence on deforestation rates and the evolution of these parameters can be projected into the future.

In the case of this feasibility study, only three points in time have been observed and in consequence mean annual areas of deforestation are available for only two time periods. Consequently we could have used used a linear model with the following equation:

$$A_{BSL,RA,unplanned,t} = m * t + int$$

Where:

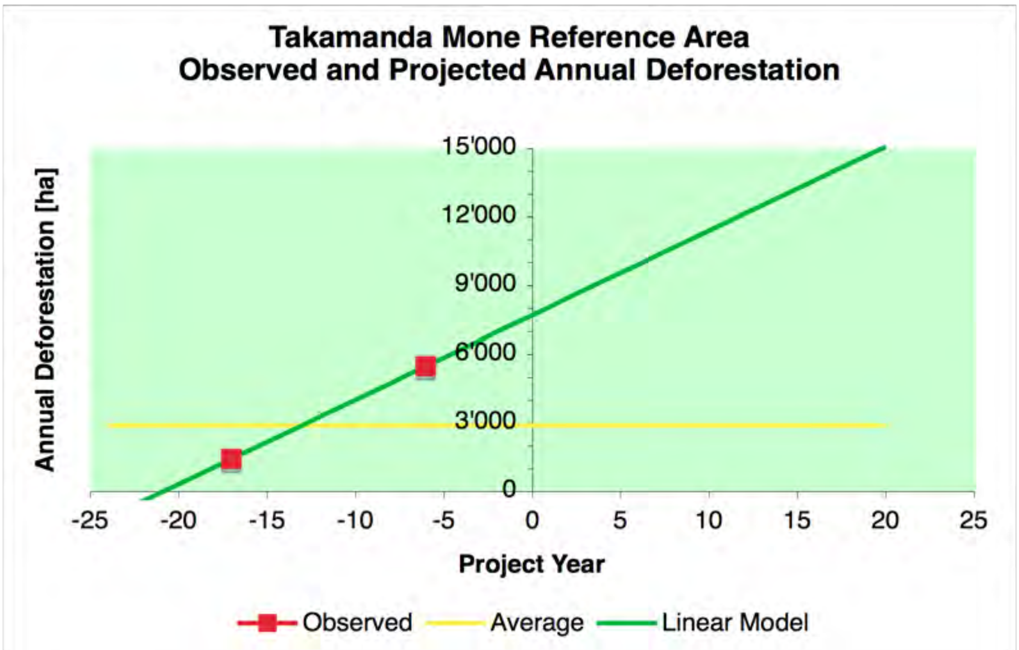
$A_{BSL,RA,unplanned,t}$	=	Projected area of unplanned baseline deforestation in the reference area in year t; ha
m	=	Slope; no unit
int	=	Intercept; ha
t	=	1, 2, 3, … t years elapsed since the projected start of the REDD project

Based on the values on historic deforestation in the reference area presented in table 12 the following values have been calculated:

m	=	369.36
int	=	7,697.18

This linear model would have led to a strong increase of the annual rate of baseline deforestation in the reference area and was not considered conservative enough for a feasibility assessment. It is also quite difficult to use increasing deforestation rates in the modelling process described below for

Figure 10: Historic and projected annual areas of deforestation for the reference area



locating future deforestation inside the project area. Therefore, we finally used the average annual rate of deforestation of 2,895 ha/year, which is based on the average annual rate from the two historic periods, in order to project amounts of unplanned deforestation into the future.

Figure 10 provides a graphic representation of the linear model of the evolution of annual areas of unplanned baseline deforestation as well as of the average deforestation rate over the historic reference period in comparison with the values that have been developed in the analysis of historic deforestation in the reference area.

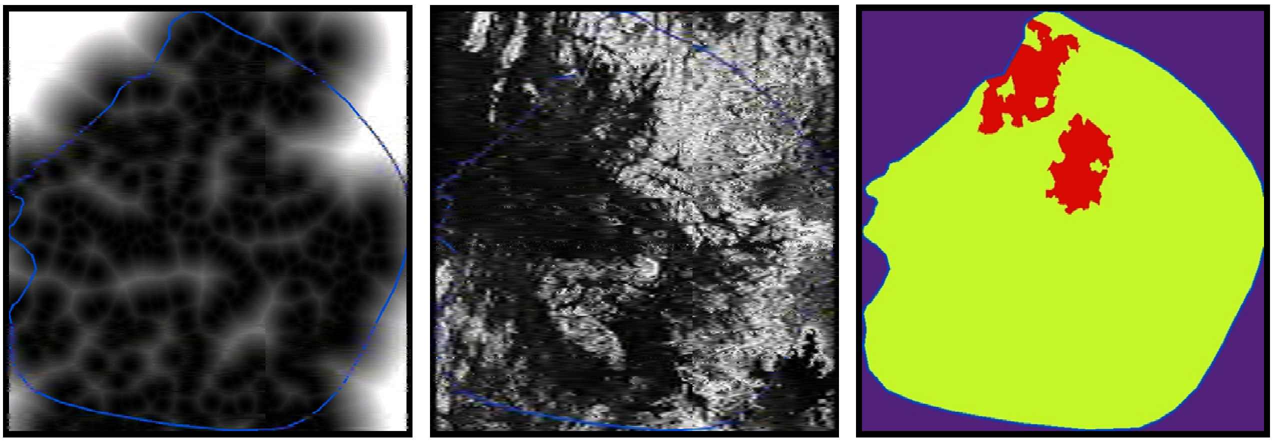
5.2 Areas of Unplanned Baseline Deforestation in the Project Area

In the case of a frontier deforestation configuration as is the case in the Takamanda-Mone landscape, locations of unplanned baseline deforestation in the project area have to be determined through a process of spatial modelling of future deforestation in the entire reference area. The objective of this process is to develop a deforestation model that predicts which forest areas inside the reference area including the project area would be deforested during the project period, or at least during the first baseline period, without the intervention of the project.

5.2.1 Model development

The development of spatially explicit models of unplanned deforestation is a two-stage process. Stage 1 is the calibration stage where a model that relates some combination of the driving factors of deforestation to locations of deforestation seen in a historic period is developed. Stage 2 is the validation stage that confirms the quality of the model developed in Stage 1 by comparing a projection of deforestation to true deforestation seen during the second historic period. In the case of this feasibility assessment, the calibration data used was the data produced by the analysis of historic deforestation between 1986 and 2000, and validated by projecting deforestation from 2000 to 2008 and comparing the projected deforestation to the true deforestation seen from 2000 to 2008.

Figure 11: Three of the factor maps used in the model of unplanned deforestation: A) distance to nearest village; B) slope; and C) management status (forest reserve, protected area)



A B C

5.2.1.1 Preparation of factor maps

Before the model of deforestation can be generated, spatial data sets, representing the forces driving deforestation, must be generated. These are spatial representations of the driving factors, described in section 1.10, and fall into the following categories: (cf. figure 11):

- **Landscape factors:** Slope, elevation, vegetation type, soil, etc.
- **Accessibility factors:** Distance to roads, distance to navigable watercourses, etc.
- **Anthropogenic factors:** Distance to settlements, distance to forest edge, etc.
- **Actual land tenure and management:** Forest reserve, protected area, communal boundaries, etc.

For this analysis we developed models using a combination of the following factors: slope, elevation distance to roads, distance to villages, distance to markets, distance to rivers, distance to nearest non-forested area, and protected area status. The distance factors were generated using a standard GIS distance tool that calculates the straight-line distance between any point in the landscape and the nearest feature of interest, such as a road, a village or non-forest patch. The slope layer was derived directly from the digital elevation model as the change in elevation over a standard distance.

Finally, the protected area status factor layer was generated using the evidence likelihood command in IDRISI and relates the amount of historical deforestation to the locations of protected areas. This analysis is useful for converting a categorical factor, such as protected area status to a continuous variable useable in the model of deforestation. These factors are the best representation of the driving forces of land cover change in the landscape, based on our experience and information.

5.2.1.2 Model calibration

Once, the historic land cover images and driving factors were prepared, the model of deforestation could be generated. This two stage process, described earlier, begins with the calibration of the model. For the calibration stage, we use the 1986 to 2000 deforestation data and different combinations of driving factors to develop a model of unplanned deforestation for the entire reference area. This is done in the IDRISI software using the Land Change Modeller (LCM) tool, which was developed specifically to help model future land cover. LCM derives a relationship

Table 11: ROC statistics for different factor combinations

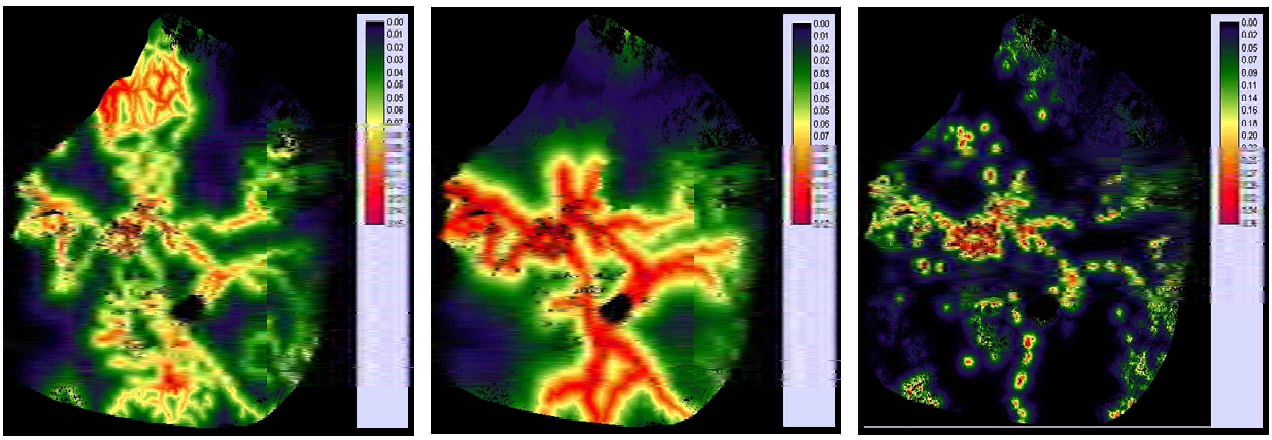
Trial Name	Factor 1	Factor 2	Fctor 3	Factor 4	ROC
Trial 30	Distance to main Rivers	Distance to all Roads	Distance to Markets	DEM	0.7312
Trial 31	Distance to Markets	Distance to primary Roads	Management Status	DEM	0.7492
Final Model	Distance to 1986 non-forest	Distance to all Roads	Distance to all villages	Slope	0.8301

between the historic land cover change and the driving factors of change using either a logistic regression analysis or a multilayer neural network analysis (see IDRISI Taiga Software Manual for full details on LCM). For this work we selected the logistic regression analysis as it provides more information about the relationship between the driving factors and deforestation as well as a clear indication of the quality of the model.

For the calibration stage, numerous trials, with different combinations of driving factors were run in order to develop a suite of models that can be compared and evaluated. Table 11 shows three trials, the driving factors included in these trials and the Receiver Operating Curve (ROC) value, which is one indication of the quality of the model. The ROC value is a standard remote sensing tool which is used to test the accuracy of land cover models and is used here as part of the logistic regression analysis to assess the quality of the model. The higher the ROC value, the better the model. The trial factors were selected based on expert opinion of what is driving deforestation. Over 30 trials were run and the model with the highest ROC statistic was selected for validation in the second stage of the process.

The calibration stages also provide an indication of the influence each factor has on deforestation. For the final model, it was shown that forested areas close to other non-forested areas, close to roads, close to villages and on low slopes had a higher probability of being converted to non-forest over the project period.

Figure 12: Three deforestation risk maps, based on three different models of unplanned deforestation: Trial 30, Trial 31, and the Final Model



Trial 30 Trial 31 Final Model

5.2.1.3 Model validation

In order to validate the model of unplanned deforestation, identified in the calibration stage, we project land cover from 2000 to 2008 based on the model and then compare that result to the true 2008 land cover map derived from the satellite image analysis. All projections of land cover are based on the deforestation risk maps (figure 12).

These risk maps are a result of applying the logistic regression equation to the set of factors used in the model in order to estimate the probability of a forest to non-forest conversion for each cell in the landscape. For this work, the deforestation risk map was applied to the 2000 land cover image and forested pixels with a high risk of deforestation were converted to non-forest for the 2008 land cover map. The amount of deforestation projected to 2008 matched the true rate of deforestation seen in the reference land cover maps from 2000-2008.

In order to test the accuracy of the projected 2008 land cover map we used the ErrMat tool in IDRISI Taiga. This tool performs a standard accuracy assessment between two land cover maps, one is the projected 2008 land cover map and the second is the reference land cover map for 2008. The output of the ErrMat command includes a table comparing the reference land cover map to the predicted land cover map, estimate of the overall error in comparison and a Kappa statistic which is a statistical indicator of the quality of the comparison. A quality model will result in a high Kappa value, and a high percentage of pixels that are the same class in both the reference land cover map and the predicted land cover map.

Table 12 compares the prediction of the 2008 land cover map to the 2008 reference land cover map. In this table, the columns represent the true land cover based on the 2008 reference land cover map and the rows represent the predicted land cover for 2008 based on the final model. The numbers represent the count in pixels for each category with the values in the diagonal representing pixels that were correctly predicted and the off-diagonals are the errors. The total true row is the sum of each True Land Cover Type columns and represents the total Forest, Non-Forest and Water pixels in the reference land cover map, and the total Predicted column is the sum across each Predicted Land Cover Type row and represents the total number of Forest, Non-Forest and Water pixels in the predicted land cover map.

From these values, an overall percent correct can be calculated to give an indication of the quality of the prediction. The percent of forested pixels correctly predicted was 95.81% (13537119 / 13576702) and he percent correctly predicted non-forest pixels was 65.99% (1565373 / 1517450). The overall Kappa Index of Agreement (KIA) value for this comparison is .6086. By comparison the KIA for the other Trial 30 was 0.5826 and the KIA for Trial 31 was 0.6002.

Table 12: Accuracy assessment table for the Final Model prediction of 2008 land cover

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">True Land Cover Type</th><th rowspan="2">Total Predicted</th></tr>
<tr><th>Forest</th><th>Non-Forest</th><th>Water</th></tr>
<tr><td rowspan="3">Predicted Land Cover Type</td><td>Forest</td><td>13,008,606</td><td>515,411</td><td>13,102</td><td>13,537,119</td></tr>
<tr><td>Non-Forest</td><td>562,830</td><td>1,001,510</td><td>1,033</td><td>1,565,373</td></tr>
<tr><td>Water</td><td>5,266</td><td>529</td><td>10,738</td><td>16,533</td></tr>
<tr><td colspan="2">Total True</td><td>13,576,702</td><td>1,517,450</td><td>24,873</td><td></td></tr>
</table>

5.2.2 Estimation of areas of unplanned deforestation in the project area

Once a final model has been calibrated and validated, we could then project unplanned deforestation into the future for the entire reference area including the project area. This was done by applying the risk of deforestation map to the latest land cover reference map (2008) in order to predict future deforestation for 2010, 2015, 2020, 2025 and 2030.

Part of the process of predicting future deforestation is to update the deforestation risk maps, based on changes in the driver variables over time. For this model, it was expected that two driving factors would change: distance to nearest non-forest pixel and the distance to nearest road. The distance to nearest non-forest pixel changes every time a new prediction of land cover is made as this new prediction includes newly deforested areas. The distance to nearest road factor was changed to include the new road linking Mamfe and Akwaya described in 3.5.1.1 that is projected to be built around 2012 in the project area. The LCM tool allows us to recalculate the risk of deforestation map to account for the changes in variables over time.

The amount of deforestation was based on the average rates of annual deforestation, taken from the two historic periods and applied forward to identify the expected deforestation at each subsequent prediction year. The results of these projections are land cover maps for 2010, 2015, 2020, 2025 and 2030 (cf. figure 13), which can then be used to identify new deforestation by comparing land cover maps from any two subsequent time periods. For example, to obtain the deforestation map for 2015, we compared the land cover map for 2010 to the land cover map for 2015 and identified all pixels that were projected to convert from forest to non-forest (cf. table 13).

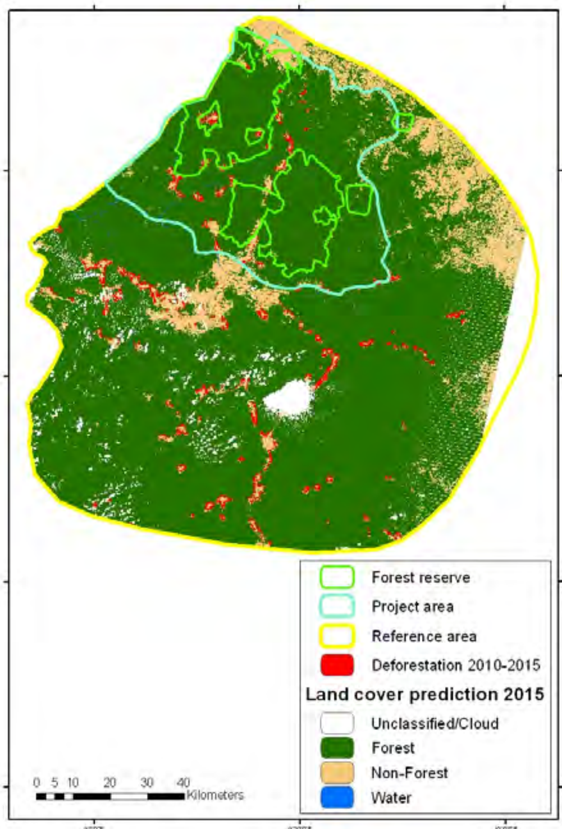
As presented in section 4.2.3 two different types of deforestation can be distinguished in the landscape depending on the two types or strata of affected forests:

- Conversion of intact forests to cropland with an emission factor of 525,99 tCO_2-e/ha.
- Degraded forests and agroforests to cropland with an emission factor of 398.75 tCO_2-e/ha.

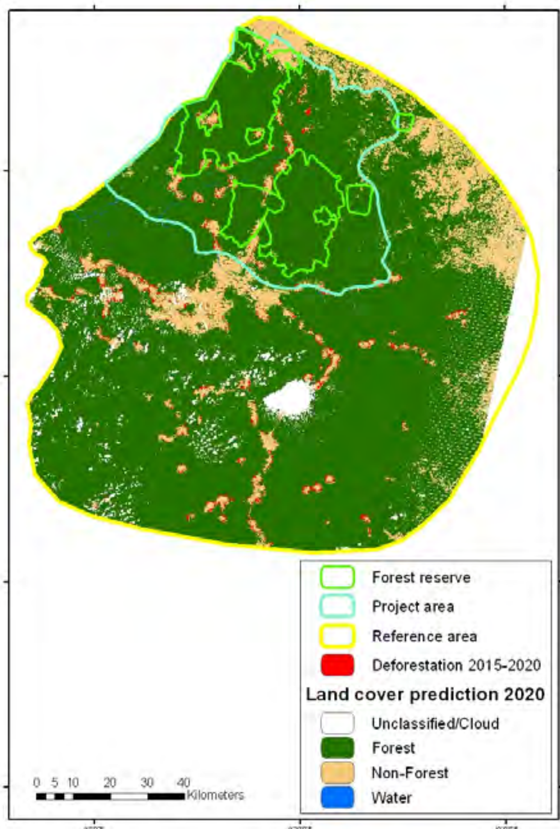
Table 13: Annual areas of predicted baseline deforestation in intact and degraded forests in the project area for the entire project period

Year	Deforestation of intact Forests [ha]	Deforestation of degraded Forests [ha]	Total Deforestation [ha]	Year	Deforestation of intact Forests [ha]	Deforestation of degraded Forests [ha]	Total Deforestation [ha]
2011	289	537	826	2021	316	586	902
2012	289	537	826	2022	316	586	902
2013	289	537	826	2023	316	586	902
2014	289	537	826	2024	316	586	902
2015	289	537	826	2025	316	586	902
2016	317	589	906	2026	329	612	941
2017	317	589	906	2027	329	612	941
2018	317	589	906	2028	329	612	941
2019	317	589	906	2029	329	612	941
2020	317	589	906	2030	329	612	941
				Total	**6,255**	**11,620**	**17,875**

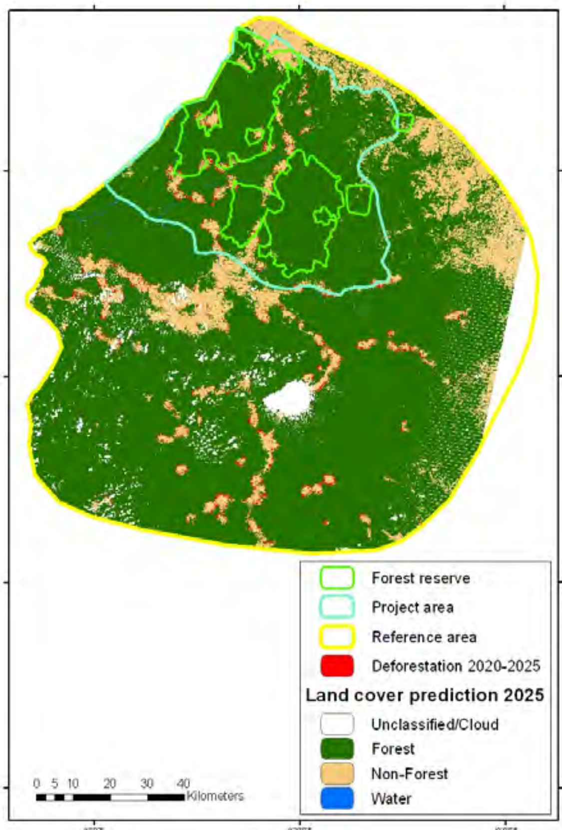
Figure 13: Deforestation predictions for 2015, 2020, 2025 and 2025



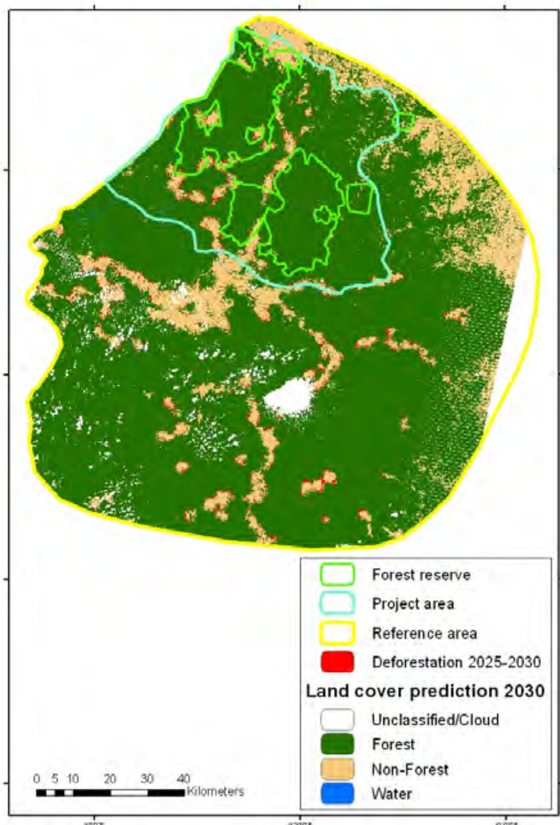
Deforestation 2010 to 2015



Deforestation 2015 to 2020



Deforestation 2020 to 2025



Deforestation 2025 to 2030

For technical reasons the analysis of historic deforestation did not distinguish intact from already degraded forests (cf. section 5.3). As degraded forests and small-scale agroforests are usually located closer to settlements and roads they are obviously more likely to be converted into croplands than intact forests. Consequently we assumed that of the total annual area of deforestation in the project area 65% would occur in already degraded forests while 35% would be deforestation of intact forests (cf. table 13).

5.3 Areas of Planned Baseline Forest Degradation in the Project Area

Several existing VCS methodologies allow for the integration of emissions from planned deforestation into the baseline scenario. For the purposes of the feasibility study, we ignore specific differences in the methodology about eligible activities (extraction of wood for local use as fuel, commercial wood extraction for charcoal production and for timber, etc.), as the detailed activities of the potential project are not yet determined.

Existing methodologies for degradation usually require that reduced degradation and reduced deforestation be considered as separate project areas, unless forest degradation is considered a process leading to deforestation. This means that a potential REDD project can include both processes in the same area. However, as the present study has the objective to assess the REDD potential in the Takamanda-Mone landscape, these aspects have not really been taken into account and forest degradation is treated separately from unplanned deforestation.

As mentioned above, we only consider planned forest degradation, driven by degradation agents with an official authorisation to do so such as logging companies and potentially councils and local communities. Consequently, estimation of areas of planned forest degradation is not based on modelling but on the analysis of logging policies in the landscape. Two main forest areas have to be distinguished:

- Permanent forest domain: Mainly Mone Forest Reserve, the Ambelle Protection Forest and the existing logging concesstions and/or FMUs in the project area.
- Non-permanent forest domain: All other forests in the project area.

5.3.1 Permanent forest domain

There are three main permanent forest domain inside the project area: the Mone Forest Reserve, the Ambelle Protection Forest (cf. section 3.2.1.2), and FMU 11004. The other FMUs mentioned in section 3.2.1.3 are situated in the wider reference area of a potential REDD project, but not the project area and are therefore not considered for estimating areas of planned forest degradation.

5.3.1.1 Mone Forest Reserve

Mone Forest Reserve covers a total area of 45,868 ha of which 45,661 ha were forested in 2008. Deforestation in Mone is the lowest in the project area, probably due to its difficult accessibility. Although some illegal logging is reported in the area, Mone's forests seem to be mostly undisturbed and no degraded forests have been localised by the 2008 land cover mapping conducted by GIZ.

Due to its expected high biomass and timber stocks, there is significant interest in allowing logging operations in Mone, which is absolutely consistent with its current status as a forest reserve. These discussions are quite advanced at MINFOF level and hence it is expected that in the absence of an intervention to exclude Mone from logging, the entire Forest Reserve could be transformed into a logging concession relatively soon.

Concessions in Cameroon are usually leased to the logging companies for 30-year rotations. Hence, in theory harvesting operations impact only about 3.3% (about 1,500 ha in the case of Mone) of the total forest area in a concession each year. Forest legislation requires that companies exclude “sensitive” areas, such as steep slopes and forests along water courses, from logging. This further reduces the annual harvested forest area. For the present feasibility assessment, we use a conservative assumption that timber harvesting affects annually 1,522 ha of intact forest inside Mone Forest Reserve as our baseline scenario.

5.3.1.2 FMU 11004

FMU 11004 is part of concession N° 1089 held by Transformation Rift Cameroon and is the only currently active FMU in the project area. The FMU covers a total area of 15,233 ha of which 14,555 ha (96%) were forested in 2008. According to our study, FMU 11004 is subject to deforestation and forest degradation. The FMU is easily accessible as the main road leading up north from Mamfe to Akwaya goes through parts of the FMU forests.

Degradation in the remaining forests appears relatively low and based on the 2008 land cover mapping the majority of forests inside FMU 11004 are still more or less intact natural forest. The management plan of concession N° 1089 is based on a 30-year rotation at 30 years. The production zone is 12,404 ha; 2,534 ha and 399 ha are designated as sylvicultural and protection zones respectively and are excluded from logging activities. For the baseline scenario, we thus assume that harvesting affects a total area of 485 ha annually.

5.3.2 Non-Permanent Forest Domain

All forests inside the project region but not included in the areas mentioned in the sections above are currently part of the non-permanent forest domain and cover approximately 200,000 ha. Harvesting may impact these forests in three different ways:

- Council forests: Forest management and property rights can be transferred to councils in which case the forests become part of the permanent forest domain. Once transferred, the council can attribute harvesting authorisations for these forests following regulations similar to the ones in logging concessions. This usually means that timber harvesting is sub-contracted to logging companies.
- Community forest: Forest management rights can also be transferred to local communities but remaining property of the state. Community forests are not part of the permanent forest domain but have to be sustainably managed by communities. This can include commercial harvesting of wood for timber and/or fuel. Harvesting operations are usually sub-contracted to specialized enterprises.
- FMU/Concession: Finally there is the possibility of creating new concessions outside the existing FMUs and forest reserves like Mone. Impact on forest resources would certainly be similar as from community managed production forests.

While there seem to be no plans to delimitate new UFAs in the landscape, there is a clear potential for the creation of council and community forests in the project area. It is however very difficult to make projections of forest areas that might be put under harvesting in a credible baseline scenario. Certain areas can be excluded such as the Mbulu Mountains to the north of Mone which are too remote and have a difficult topography to make commercial harvesting interesting.

Viable forests are located mostly in the south and centre of the project area, covering a total area of about 80,000 ha. With the same assumption of a 30-year rotation between harvesting, this would mean an annual area of planned forest degradation of about 2,500 ha. Unlike in the permanent forest domain, it is however expected that this quite important area will not be reached immediately at the start of the project period but will increase progressively over the first ten years of the project and then remain constant for the remaining ten years.

Table 14: Annual areas of baseline forest degradation on the project region

Area	Annual Area [ha]	Forest Type
Mone Forest Reserve	1,522	Intact Forest
FMU 11004	485	Intact Forest
Non-Permanent Forest	-	Intact Forest
Total	**2,007**	

As for harvesting operations in the permanent forest domain it can be expected that harvesting will be concentrated mostly in more or less intact forests presenting relatively few signs of previous degradation. However, as this management delegation to local communities is not really planned for the moment, potential reductions could not be considered under this degradation type.

5.3.3 Estimation of annual areas of baseline degradation in the Project Area

The expected areas of annual baseline forest degradation for each degradation scenario in the project area are presented in table 14. The total annual area of baseline forest degradation is estimated at 2,007 ha per year.

5.4 Estimation of Baseline Emissions

The estimation of baseline emissions is based on the emission factors of different land changes developed in section 4.2 and the annual areas of baseline deforestation and forest degradation estimated in sections 5.2 and 5.3 respectively. This process is explained in the following sections separately for emissions from deforestation, from forest degradation and from other potential emission sources.[7]

5.4.1 Baseline emissions from deforestation

Annual emissions from carbon stock changes in the project area under the baseline scenario can be estimated by multiplying the annual areas of baseline deforestation in each forest stratum (cf. section 5.2.2) with the corresponding emission factor. For the present feasibility assessment only two different forest strata were considered and we used the following equation:

$$\Delta C_{BSL,def,t} \quad = \quad (A_{BSL,def,if,t} * EF_{def,if}) + (A_{BSL,def,df,t} * EF_{def,df}) \qquad (5)$$

Where:

$\Delta C_{BSL,def,t}$ = Baseline deforestation carbon stock changes in all pools in year t; t CO_2-e

$A_{BSL,def,if,t}$ = Area of baseline deforestation in intact forests in year t; ha

$EF_{def,if}$ = Emission factor for conversion of intact forest to cropland; t CO_2-e/ha

$A_{BSL,def,df,t}$ = Area of baseline deforestation in degraded forests in year t; ha

$EF_{def,df}$ = Emission factor for conversion of degraded forest to cropland; t CO_2-e/ha

t = 1, 2, 3, … t years elapsed since the projected start of the REDD project activity

Results are presented separately for each year in table 15 below.

7 Baseline emissions must be calculated not only for the project area but also for the leakage belt, where it can be used to estimate emissions from leakage, which have to be deduced from total emission reductions. As we did not define a leakage belt t and the baseline emission estimates below are concentrated on the project area.

5.4.2 Baseline Emissions from forest degradation

Annual baseline emissions from planned forest degradation in the project region can be estimated by multiplying the annual area of forest degradation in the baseline case (cf. section 5.3.3) with the corresponding emission factor. As we assume that harvesting will concentrate on intact forest and no FSC certified or other improved harvesting will occur in the baseline scenario the following equation was used:

$$\Delta C_{BSL,deg,t} = A_{BSL,deg,if,t} * EF_{deg,if,cl} \quad (6)$$

Where:

$\Delta C_{BSL,deg,t}$ = Baseline degradation carbon stock changes in all pools in year t; t CO_2-e

$A_{BSL,deg,if,t}$ = Area of baseline degradation in intact forests in year t; ha

$EF_{deg,if,cl}$ = Emission factor for degradation of intact forest by conventional logging; t CO_2-e/ha

t = 1, 2, 3, … t years elapsed since the projected start of the REDD project activity

Again we assume that the annual area of baseline degradation would increase over the first ten years of the project period and then remain constant (cf. table 15). Consequently, the annual baseline emissions from carbon stock changes due to forest degradation can be estimated as follows for the each year of the project period:

$$\Delta C_{BSL,deg,t} = 2{,}007 \text{ ha} * 40.16 \text{ t } CO_2\text{-e/ha}$$

$$= 80{,}601 \text{ t } CO_2\text{-e}$$

Results for the other years are presented separately for each year of a potential future REDD project in table 15 below.

5.4.3 Other baseline emissions

Most VCS methodologies allow baseline estimations to include other greenhouse gas emissions such as non-CO_2 emissions from biomass burning, CO_2 emission from fossil fuel combustion related to deforestation activities, and N_2O emission from nitrogen application on the alternative land use. For the purposes of the feasibility study, we do not include other greenhouse gas emissions in our baseline scenarios for two main reasons.

First, although other greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O) might be emitted during biomass burning, their contribution to the total potential of global warming effect from deforestation are usually considered non-significant.[8] Second, we were not able to provide detailed estimation of baseline emissions from fossil fuel combustion or fertilizer application due to a lack of information.

8 Houghton, R. A. 2005. Tropical deforestation as a source of greenhouse gas emissions. In: Moutinho, P. & Schwartzman, S. eds. Tropical deforestation and climate change. Instituto de Pesquisa Ambiental da Amazônia - IPAM; Environmental Defense. Belém, Pará, Brasil. 131 p.

5.4.4 Total baseline emissions

Total baseline emissions can be estimated by adding up emissions from deforestation and from forest degradation using the following equation:

$$\Delta C_{BSL,tot} = \Delta C_{BSL,def,t} + \Delta C_{BSL,deg,t} \quad (7)$$

Where:

$\Delta C_{BSL,tot}$ = Total baseline emissions from carbon stock changes in year *t*; t CO_2-e

$\Delta C_{BSL,def,t}$ = Baseline deforestation carbon stock changes in all pools in year *t*; t CO_2-e

$\Delta C_{BSL,deg,t}$ = Baseline degradation carbon stock changes in all pools in year *t*; t CO_2-e

t = 1, 2, 3, … *t* years elapsed since the projected start of the REDD project activity

Results are presented separately for each year of a hypothetical future REDD project in table 15 below.

It has however to be emphasised once more that as for the present feasibility assessment detailed project areas are not yet available, these estimates only apply to the general project region defined in section 4.1.1. In order to compare emission reductions for different project scenarios, more detailed baselines will be developed for different possible project scenarios in section 6.

Table 15: Estimated annual baseline emissions from deforestation and forest degradation in the project area for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	367,379	80,601	447,980	2021	400,480	80,601	481,081
2012	367,379	80,601	447,980	2022	400,480	80,601	481,081
2013	367,379	80,601	447,980	2023	400,480	80,601	481,081
2014	367,379	80,601	447,980	2024	400,480	80,601	481,081
2015	367,379	80,601	447,980	2025	400,480	80,601	481,081
2016	404,583	80,601	485,184	2026	419,489	80,601	500,090
2017	404,583	80,601	485,184	2027	419,489	80,601	500,090
2018	404,583	80,601	485,184	2028	419,489	80,601	500,090
2019	404,583	80,601	485,184	2029	419,489	80,601	500,090
2020	404,583	80,601	485,184	2030	419,489	80,601	500,090
				Total	**7,959,655**	**1,612,020**	**9,571,675**

6 Project scenario

While the baseline scenario presented in section 5 describes what would happen in the project area and the wider reference area, the project scenario tries to estimate what impact different REDD project options and activities could have on deforestation and forest degradation in the selected area. Typically this allows the project developer to estimate the ex-ante emissions reductions by comparing the project scenario with the established emission baseline (cf. section 5). The same process is also used to verify ex-post the project's performance.

In the context of the Takamanda-Mone REDD feasibility assessment, the activities to reduce deforestation and forest degradation are not yet defined and therefore the present section will:

- Identify a number of project options to reduce deforestation and forest degradation in the Takamanda-Mone landscape.
- Analyse feasibility and potential impact on deforestation and forest degradation of the identified project options.
- Evaluate the potential for leakage through activity displacement and from market effects for each considered option
- Combine the discussed project options following the analysis of the feasibility of the options in order to develop a number of potential project scenarios.
- Compare the expected project emissions from deforestation and forest degradation of each scenario presented in section 5 and estimate their REDD potential.

6.1 REDD Project options and criteria for feasibility

Based on the analysis of historic deforestation and its main agents, drivers and underlying causes, we identified a number of options that merit further analysis for[9]:

- Reducing emissions from unplanned deforestation due to conversion of forests to crop land by small scale subsistence farmers
- Reducing emissions from forest degradation caused by legal commercial logging within Mone Reserve and possibly the wider landscape,
- Reducing emissions from forest degradation caused by illegal informal timber exploitation across the landscape.

For each option under these project categories, we evaluate the likelihood that these activities will generate the expected emission reductions and the feasibility of their implementation using the following criteria and questions for guidance.

- **Socio-political** aspects: We evaluate the social and political environment of natural resources management in the landscape and country. Specific questions that should be evaluated include:
  - Is the proposed option supported by national legislation and activities? Is there a precedent in the landscape or region?
  - Is there stakeholder support for these proposed measures? Is there strong opposition?
  - Does the implementation of the proposed option contribute to the development of the national REDD strategy?

9 Options not considered to amount to a viable project scenario include:
- Reducing emissions from planned deforestation due to potential future large-scale mining projects.
- Reducing emissions from planned deforestation by potential future agro-business such as oil palm.

- **Technical aspects:** We investigate the technical feasibility of implementing the proposed option in the field. Specific questions include:
  - Are there proven techniques to implement the emission reducing measures related to the proposed options?
  - Is there experience in the project area or country implementing such measures?
  - Are there local and national organisations that could support implementation of the proposed activities?
  - Are these techniques cost effective?

- **Methodological aspects:** The ability to certify a project under the VCS standard using existing methodologies should be considered as a step to assess the feasibility of selling future generated credits on the voluntary and later regulated market. A first rough screening of the baseline options identified above shows that they are in principle all eligible under the AFOLU category of VCS, more specifically as REDD and IFM project types. Specific questions that should be answered for each scenario are:

  Are there methodologies to certify the emission reductions? Where methodologies exist, are they applicable to a potential project context in the Takamanda-Mone landscape?
  - Are there methodologies to certify the emission reductions? Are they applicable to a potential project context in the landscape?
  - Can start dates of projected operations be defined? Does documentation exist (planning permits, harvesting plans etc.)?
  - Can eligible reference areas be defined according to the methodological requirements?

- **REDD-specific aspects:**
  A key requirement for all carbon projects is that emissions must be real additional permanent and verifiable. Thus to assess the feasibility of an option, certain REDD specific criteria must be evaluated, including aspects related to additionality, permanence and leakage. Below are a list of some of the questions related to each one of those aspects:
  - **Additionality aspects:**
    - Are the proposed measures already included into existing legislation and regulations?
    - To what extent are the above-mentioned legislation and regulations enforced?
    - Are potential revenues from emission reductions essential for implementing the proposed measures or would they be financially interesting on their own?
  - **Leakage aspects:**
    Related to the potential displacement of deforestation and forest degradation to outside the project area. Specific questions:
    - Can deforestation due to immigration (vs. resident population) be quantified or controlled?
    - Does the proposed option integrate leakage mitigation measures and how efficient are these measures expected to be?
  - **Non-Permanence aspects:**
    Aspects related to risk affection the durability of the expected emission reductions and their mitigation through the non-permanence buffer. It has to be noted that there is a maximum risk rating above which a project is not eligible anymore. Specific questions:
    - How important are internal non-permanence risks related to project management, financial viability, opportunity costs and project longevity?

- How important are external non-permanence risks related to land tenure and security, community engagement and governance?
- How important are non-permanence risks related to natural events like fires, extreme weather events and geological risks?

- **Other considerations:** In addition, non-emissions related benefits of each option are examined, in order to evaluate co-benefits, durability of measures and financial feasibility. The following questions are investigated.
  - Is there community involvement? Are there ways to structure option to empower and benefit local populations
  - Is there contribution to biodiversity conservation?
  - Is there potential for raising funds other than from emission reductions?

6.1.1 Options for reducing agricultural conversion of forest

As demonstrated in section 5, the main deforestation driver in the Takamanda Mone landscape is the conversion of forestland to agricultural land by small-scale subsistence farmers. These rates are still relatively low for the moment, but the historical deforestation analysis shows an important increase after 2000 likely related with population growth in the area. The planned improvement tothe road leading north from Mamfe between Takamanda National Park and Mone Forest Reserve will further increase human pressure on forestland and likely make the area more attractive for commercial agriculture.

There are three options addressing this driver:

- Reduce agricultural expansion by improving agricultural productivity.
- Increase value of standing forests through sustainable, community based management.
- Improve management and control of new protected areas.

These options will be further analyzed in the following sections based on the criteria presented above.

6.1.1.1 Option 1.1:Improved agricultural production

Description:

Interventions for increased agricultural production aim at reducing the expansion of subsistence and commercial agriculture that could be a result of the expected increased market access through better access to certain parts of the project area, possibly combined with a certain influx of immigrants. Possible approaches include increasing agricultural productivity, introducing or promoting certain types of agroforestry (such as shade grown cacao or coffee) and palm oil plantations, and concentrating agricultural development on lands that have already been deforested in the past in order to reduce needs for new conversions.

Feasibility:

From a political, technical and methodological standpoint, this option is quite feasible; however, there are several challenges in terms of REDD project design to basing a project simply on introduction of these methods. The impact of agricultural intensification is also problematic.

- Generally, there is significant political support for introducing activities to improve agricultural productivity, as it is a key part of the development strategy of Cameroon. Agroforestry systems such as cocoa and coffee play an important role in this strategy. In addition, the national REDD strategy will likely highlight links between REDD and improved agriculture. Hence from a broader political standpoint, this option is quite feasible.

- In terms of local interest, experience indicates that local farmers are generally very interested and open to improved agricultural techniques and agroforestry models such as cocoa and/or coffee plantation in forests are already practiced in the landscape. In the Takamanda-Mone landscape, consultation is needed to assess interest in this option and to structure agricultural extension outreach and to link farmers to market. Our research suggests that to date there has been little NGO involvement in agricultural activities in the landscape, most of which are subsistence based.
- From a technical standpoint, addressing these limitations should not be difficult. Precedents exist to introduce these types of interventions in the region such as the GAF-KfW project and there is significant potential for increasing small-scale agricultural productivity building on this project. Many national NGOs work on agriculture and one would need to be identified that would be willing to work with communities. Soils are quite fertile, but topography varies so areas of extreme relief like those in the northeast would have to be excluded.
- From a methodological standpoint, we have already noted that there are at least two frontier methodologies that could be applied to project scenario:
    - VM 0007: Methodological REDD framework developed by Avoided Deforestation Partners includes a module on unplanned frontier deforestation.
    - VM0015 The frontier deforestation methodology developed by Amazonas Sustainable Foundation and BioCF.

  There are a number of challenges however to applying these methodologies. For example, the delimitation of the project are could be quite difficult since the implementation would be in areas that are already deforested and thus do not comply with the definition of the project area presented in section 4.1. In fact it would be hard to structure an intervention and understand its impact on forests in a controlled way without additional land use planning.
- Other REDD requirements might also be hard to meet. For example, it is not clear whether the introduction of such activities would be additional, if the increased production would be sufficient to motivate people to maintain forests as the income from deforestation is probably higher than from carbon.
- Permanence may also be an issue since the impact of agricultural intensification is still very much debated. Theoretically, such interventions reduce the need for new deforestation, but many studies have shown one of the unintended consequences of greater efficiency is making deforestation more profitable in a*reas that previous*ly were too difficult to access or not productive enough. In fact, such interventions may push communities away from subsistence agriculture to commercial agriculture, which can be more destructive than the original threat.

Potential impact:

Generally however, if these activities are implemented in the context of a wider land use planning process, negative effects can probably be minimized. In this sense, agricultural interventions function more like as a leakage management tool than the option that reduces deforestation. Integrating agroforestry systems, shade grown systems or planting tree based crops, could be interesting complement to intensification. As agroforestry likely cannot provide sufficient income to effectively reduce deforestation if implemented alone, additional income from the sale of carbon credits generated through emission reductions help make these incentives more tangible. But to make this possible, there is a need to clarification of carbon rights as the land is owned by the state but interventions would be conducted by local people.

Conclusion:

The feasibility of agricultural intensification as a project activity thus depends significantly on it being implemented within a broader context of land use planning and additional incentives. On its own its emissions reduction potential is relatively low and it could be difficult to link emission reductions directly to the implemented activities. Introduction of these activities however could be a part of a broader scenario to reduce emissions from unplanned deforestation.

6.1.1.2 Option 1.2: Community-based forest management

Description:

The introduction of community-based forest management could potentially reduce deforestation by providing a viable alternative to agriculture, increasing the value of intact forests.

Possible approaches include the creation of community or council forests, which are outlined in Box 1. Community forests are non-permanent forest domain and revenues are managed locally but the use rights are still owned by the state. The zoning and transfer of usage rights that come with council forests in particular could be a strong option for addressing this deforestation threat.

Activities for this option would include delimitation of the zone, transfer of management and property rights (depending on the approach), creating an institutional framework for forest management, building forest management capacities on the local level, market support and monitoring.

Feasibility:

Community-based forest management could be a strong option for reducing unplanned deforestation; however, significant work is needed before to understand local interest in the activity, political support and to build up capacities. Further, the effectiveness would be improved in the context of a broader land use planning process.

Community-based forest management plays an important role in national forest policies and strategies. In fact, one of the principle reforms in the 1990s was to allow for local actors to participate in management and advocate for greater decentralization. It is also expected to be one of the low emissions development strategies proposed in the national REDD strategy.

On a technical level it has to be noted that no council or community forests currently exist in the project area; however, there are models from other areas that can be applied, most notably the Nguti Council Forest that is being supported by KfW. Much can be learned from this experience especially to understand the time required to designate forest, transfer management and build capacity. Generally, local communities and other local stakeholders seem to be interested in taking over forest management responsibilities from the state. Land tenure regimes (customary) in the landscape are quite strong and transparent and communities seem well organized in the area. In areas where there are no logging concessions or protected areas, they are already the de facto managers of the forests. However, forest management capacities are low and hence significant resources would be required to build capacity. Again as there are no entities in the project area working on communal models of management, we would need to identify a potential partner at the national level to help build this capacity. Examples are the Technical Centre for Council Forests (CTFC) and the Program to Support Sustainable Management of Council Forests in Cameroon (PAF2C).

The methodologies for unplanned frontier deforestation mentioned above would certainly apply to this option. Definition of the project area would be simpler than above, but again a stakeholder consultation would be needed to find an appropriate location that intersects with deforestation and areas of strong customary ownership. In principle all forests in non-permanent forest domain and potentially interesting for community management could be part of a REDD project area.

In terms of REDD specific criteria, the introduction of community forest management is likely to be additional as the start up costs of capacity building and setting up the legal framework would be expensive. Management and monitoring could also be offset by potential carbon revenues. One can argue too that without the potential carbon revenues, government officials would not likely grant these rights. However, this requires clarity on carbon rights, ownership and benefit sharing. For council forests, this clarification may be easier given that ownership is devolved to councils, but in communal forests the ownership is still with the state. Hence, clarification of carbon ownership would have to be outlined in the management contract between forest authority and communities in the latter case.

Similarly permanence is greater with council forests because of the change in zoning to permanent forest domain, while with communal forests there is no legally binding requirement that prevents the government to change the designation of the area.

Leakage is not a problem with either communal or counsel forests since communities will likely not move outside the project area. A strong system of grievance and conflict mitigation would have to be implemented however. The integration of community forests within a broader land use planning process however would make a project more stable.

Potential impact:

Despite the political, technical and methodological feasibility of this option, there are several issues to consider. First, to date we know of only few detailed long-term studies on the impact of community forest management on deforestation especially in Cameroon. Yet in theory, moving communities away from agricultural-based livelihood may result in greater value for forests. There are cases where communities and councils just sub-contract forest harvesting to private operators; this strongly reduces benefits.

Further the process of establishing these community or council forests may be long in order to build forest management capacities and establish a management structure, governance rules, and benefit sharing. This may require additional co-financing. Finally, clarifying carbon rights and benefit sharing for the different management structures will also take time and may be done at the national level.

Nonetheless, we believe that if properly designed, this project options could be expected to decrease baseline emissions by at least 50%, potentially more if combined with leakage management activities as described in the previous section. Most interesting areas for implementing this option are of course forests relatively close to existing villages, although for council forests they might also be more remote. As shown in section 5, these art h forests in the landscape that are under the biggest human pressure and most likely to be deforested in the near future. Consequently, potential income from emission reductions would certainly be high compared with the other options.

Conclusion:

Community-based forest management seems to be an interesting option for reducing emissions from deforestation, particularly in areas where there are no plans for creating new UFAs and/or logging concessions, especially in zones of high deforestation. While council forests clearly offer more long-term security, their creation is expensive and working with smaller community forests might be easier.

One of the major drawbacks of community-based forest management seems to be the elevated costs, particularly for the property transfer in the case of council forests. It seems clear that these costs could not be covered even on the long term by future incomes from emission reductions, although the additional revenue might be an incentive for governments to agree to them with donor funding.

The higher non-permanence risks for community forests could be mitigated by delimitating them in the framework of a landscape wide land use planning exercise that would clearly identify the forests to be conserved on the long term and engage the managing communities.

6.1.1.3 Option 1.3: New Protected Areas

Description:

The creation of new protected areas would aim at reducing deforestation by improving management and control in areas delimitated for long-term forest conservation and biodiversity protection. Management of these areas could be delegated to national or international actors in a process similar to the management transfer to local communities. Another approach would be to establish some kind of conservation contract between the government or REDD project promoter and local communities in order to prevent illegal activities in areas that are not actively managed for production purposes.

The creation of new protected areas is particularly appealing to areas where biodiversity conservation and carbon benefits intersect. Besides the initial creation of the protected area, investment would be needed to implement management structures, build capacity of managers, and design and implement control measures and monitoring. Other possible design structures that might be considered is the creation of co-management structure with communities and local capacity building.

Feasibility:

The creation of a new protected area would have a significant impact on emissions if properly designed and implemented.

Although feasible as a REDD project, there are some political and social obstacles to this option for the Takamanda-Mone area, from the side of the forest administration, as well as from local and regional stakeholders. This is particularly the case regarding Mone Forest Reserve, where plans to create new logging concessions seem to be quite advanced at MINFOF.

As mentioned in section 3, the Takamanda-Mone landscape is home to the Cross River Gorilla, the most endangered gorilla in the world and improving protection of the species is of high priority at the national and international level. Despite the creation of the Takamanda National Park, there remain a number of important habitats and breeding grounds that are currently under no particular management status. In fact, only a few studies have tracked the gorilla's habitat outside the park. From a biodiversity standpoint, identifying these habitats and maintaining connectivity between these habitats is of an utmost priority.

Technically, the institutional and legal framework for the creation of new protected areas exists in Cameroon, and there are examples of NGOs in the area managing protected (such as WCS with the Takamanda National Park). An alternative model however may want to be considered which includes co-management with communities and use of conservation contracts. These were not part of the re-designation of Takamanda National Park, but could work in other areas of the landscape especially since customary land tenure is strong and communities are well organized. Examples in other countries demonstrate that a combination of co-management and conservation contracts can lead to good access control and enforcement of the new protection status. Local support for such an initiative however is uncertain and would have to be assessed as part of a larger consultation process.

In terms of methodology, the creation of a new park again would fall under unplanned frontier deforestation. Unlike some of these other options, there would be little problem with delimitating the project area based on requirements. The additionality of the new park would be without questions, as the carbon project would go to support park activities. Permanence would not be an issue as long as the carbon revenues are sufficient to support park management and control and vigilance. However several challenges do exist:

- First, the political and social support for a new national park may be sparse. For this reason, alternative governance structures and benefit sharing should be considered.
- Without community support and involvement, leakage will be a significant problem as deforestation will likely be pushed outside the park boundaries.

Potential impact:

A well-financed, well-managed protected area that is formed with community support could have a very high impact on reducing emissions, with reduction of 75% or more. However, the question remains about where to place such a park to generate both emission reductions and co-benefits. Sparse biodiversity data exists outside Takamanda National Park. There is some evidence of Cross River gorillas in the Mbulu Mountains and in northern part of Mone, but no surveys of other areas exist to our knowledge. Data on other mammals however also shows strong abundance in the area between Takamanda National Park and Mone Forest Reserve.

Conclusion:

Deforestation in Mbulu and Mone are very low, likely due to their low accessibility, and hence even a relatively high reduction percentage would result in relatively low net emission reductions. A carbon project formed in these areas alone may not generate enough financing to support park management. This also increases the risk of non-permanence of emission reductions, unless other sources of income can be identified. Nonetheless, the creation of new conservation areas may be feasible if designed in an inclusive manner that would ensure reduction of deforestation and long term sustainability.

6.1.2 Reducing impacts of legal logging

For reducing impacts of legal logging, there are two main options described below:

- Improved legal logging
- Logged to non-logged forest

6.1.2.1 Option 2.1: Improved legal logging

Description:

Improved legal logging is one of the options for reducing emissions from forest degradation caused by legal commercial logging within Mone Reserve and possibly the wider landscape. Improved practices for legal logging and possibly, Forest Stewardship Council (FSC) certification could be promoted as a way to reduce the potential impacts and emissions of conventional logging as predicted under a BAU scenario.

This option would all fall under the Improved Forest Management (IFM) category of AFOLU projects and possible project interventions could include:

- Reduced impact logging (RIL) practices in concessions

- Compulsory engagement of logging company towards certification or otherwise demonstrable RIL practices, along with concrete milestones into conditions of a concession tender (cahier de charges of a future operator.)
- Introduction of sylvicultural measures reducing the volumes harvested (extension of rotation) or increasing growth and carbon sequestration after harvesting.

Feasibility:

Theoretically improved legal logging is highly feasible option for the landscape; however, specific identification of RIL techniques will be case specific and emissions impact based on current practices may requires additional data.

From a political and socio-economic standpoint, introducing reduced impact logging seems quite feasible. In fact, there is strong evidence of an increasing acceptance of certified forestry in Cameroon, as demonstrated by the fact that all the operators involved in the Takamanda-Mone landscape operate certified concessions elsewhere. This does raise a question of additionality, if the managers were already considering the improved forest management trend, which will be discussed further below.

From a technical standpoint implementing practices that reduce emissions is not an obstacle. RIL and other IFM techniques is no problem as many of them are already implemented in FSC certified concessions in Cameroon and elsewhere in Central Africa. However, some piloting may be needed to understand the emissions impact of different practices in Cameroon.

There are obviously many variations of IFM but for the moment only one approved VCS methodology exists for the certification of emission reductions generated through the extension of rotation age. No draft or approved methodology exists for improved practices to reduce emissions from logging damages, e.g. RIL as practiced in certified concessions. However, several studies on the potential emission reductions related to RIL have been conducted recently in Central Africa providing valuable information and experience that could help inform this development and extension beyond a particular local context. A challenge is almost certainly to define methods that can reliably capture the relatively low differential between biomass impacts of different active logging practices. Some work to this end has been conducted through the GAF study of FSC in Cameroon and WCS's study of RIL in Gabon. Testing the climate impact of specific practices in Cameroon might be interesting as first step of a REDD project.

The additionality of improved forest logging will depend on the practices implemented. International initiatives like FLEGT and the Lacey Act mean that there is increased enforcement of legal requirements for logging. A REDD project most likely must go beyond the legal requirements. Given the increasing interest in forest management certification and related standards regarding reduced harvesting impact (e.g. FSC criterion 6.5 on minimizing forest damage during harvesting and road construction), a company might also have to demonstrate that they would not have adopted such practices without additional carbon revenues generated by emission reductions. This should be relatively easy as even FSC certification allows one to access certain markets, especially in Europe and the US, but does not really give a price premium.

There is a certain potential for market leakage if the logging company compensates for reduces harvested volumes in another concession. However this is only related to the extension of the rotation age and not to RIL practices as they usually do not result in a reduction of harvestable volumes. As harvesting occurs only once every rotation in a given area, non-permanence of emission reductions from RIL techniques is not likely to be an issue. It will have to be taken into account for sylvicultural measures as these might be reversed in the following rotation, leading to increased emissions.

Potential impact:

The impact of RIL on emissions from degradation will depend on the practice that is introduced but emission reductions are expected to be relatively low per area unit, as already discussed in section 4.2. However, as logging concessions are usually quite large, even relatively low differentials between conventional and improved management might be sufficient to motivate logging companies to implement improved practices. As shown in section 4.2 on emission factors, emissions from improved logging are expected to be more than 50% lower than the ones resulting from conventional industrial harvesting. In the context of community-based forest management, more artisanal logging probably has even less impact on carbon stock and the potential for emission reductions could be higher and contribute to motivating local communities for conserving forests and managing them sustainably.

Conclusion:

In summary, introduction of RIL techniques as a project category is generally quite feasible, although identifying specific practices and measuring baseline data is needed, as well as initiating discussions with companies operating in the TOU. The provision of financial incentives from carbon will likely defray the extra costs for technical support and monitoring, and potentially an interesting source of diversified income in the long run for companies. However, the development of applicable methodologies combining improved logging practices with avoided logging and potentially reduction of deforestation will be challenging, as well as the identification of appropriate boundaries of the project area. The latter should certainly be based on a landscape wide integrated process of land use planning.

6.1.2.2 Option 2.2: Avoided legal logging

Description:

Avoided legal logging is the second option for reducing emissions from forest degradation. As opposed to the improved legal logging, avoided legal logging would prevent the start of any commercial logging operations, rather than just change logging practices. Avoided legal logging is particularly appealing in areas where carbon and biodiversity goals overlap, such as in parts of the Mone Forest Reserve.

This intervention could be guaranteed through the establishment of a protection status by the government (or binding long-term conservation agreement with a potential concession holder). To compensate for the loss, compensation (most likely through monetary payment) would have to be distributed at multiple levels, including the national government, local communities, as well as potentially a commercial operator. In addition, obvious opportunity costs to the local population may also be compensated such as foregone infrastructure development and employment (logging and processing industry), which may far exceed formal fee payments.

A variation of avoided legal logging could be to designate only a part of an area as a conservation set-aside (rather than the full retirement of a concession). This conservation concession approach may be a politically feasible alternative to full protection. The process of designation could take the form of either limiting the extent of a formal concession or expand conservation set-asides in a High Conservation Value Framework (HCVF) within an active commercial concession (e.g. increase typical set-asides from 10% to 30% of area, overlapping with gorilla habitat).

Feasibility:

The option of avoided legal logging depends significantly on political and economic considerations, rather than methodological ones.

Changing the designation of Mone, while beneficial from a biodiversity and emissions standpoint, will likely not be able to overcome the political barriers and opportunity costs of this action through carbon payments alone. Stakeholders doubt that the non-monetary benefits of a concession such as infrastructure development and maintenance, could be provided in the absence of a commercial logging operator. The wider development impact for the country (secondary industries, employment) of well-organised logging is also a matter of concern. On the other hand, the feasibility of setting aside a portion of the forest may be deemed more feasible from a political and economic standpoint, especially if it is integrated into a larger strategy to reduce emissions in the landscape through the introduction of other RIL techniques and high conservation value assessment of the landscape.

There are much less concerns regarding the technical feasibility of this option, as conservation set asides are commonly used in areas of biodiversity and cultural importance. For FSC certification for example, principle 9 sets standards for maintaining areas of high conservation value, such as wetlands, which must not be developed. However, delimitation of these areas of high conservation value can be quite challenging and less general criteria and indicators will have to be developed for implementation in the Takamanda-Mone landscape.

Potential methodologies that could be adapted for this scenario include VM0010 Methodology for improved forest management: conversion from logged to protected forest, which deals with untouched forest and VM0011 Methodology for calculating GHG benefits from preventing planned degradation which allows for previously logged and intact tropical forests. The company Ecosystem Restoration Associates (ERA) is also developing a newer methodology for the Democratic Republic of Congo, which may be applicable. Methodological questions remain however such as what kind of projections of baseline management practices are possible? Is there a possibility to using real logging practices in the baseline, instead of just the legal requirement, given that to date most companies are below legal requirement.

In terms of additionality, a project that sets aside a portion of a concession for conservation should easily be able to show additionality. For a place like Mone, proving additionality for the entire concession set aside would require clear documentation of government's intention to lease it, which could be a bit precarious given that it has not yet been leased.

There is a clear potential for market leakage if logging activities that do not happen in the project area are compensated through increased logging in other parts of the country. Some sort of documentation on baseline logging may be needed.

The permanence of either full avoidance or a conservation set aside depends on the implementation of the project. Sufficient funds would need to be allocated to patrol and monitor the area. In the case of full avoidance, there may also be higher risk of impermanence if lost opportunity costs to communities are not addressed through some sort of compensation or livelihood activity. In risk of impermanence also decreases if avoided legal logging project is integrated into a broader land use planning process.

Potential impact:

The option of avoided legal logging faces a number of political and socio-economic barriers particularly for Mone Forest Reserve. As a project scenario, it may be most feasible in the context of a conservation set aside inside an industrial logging concession or in areas under community forest management. If properly implemented this option, like creation of a new national park could have strong impact on emissions from degradation, reducing them by about 75%, more if illegal logging in the area can be controlled.

Conclusion:

Given the global importance of the Cross River gorilla and the fact that important habitats of the sub-species are scheduled for harvesting, this option should not be ignored. Additional data is certainly needed to better understand the full range of the gorilla in order to determine the proper configuration of such a set aside and to increase corridor linkages with the Takamanda National Park especially through the Mbulu Mountains. Again, the feasibility and profitability of this option may work best in the context of a broader land use planning framework.

6.1.3 Option 3.1 & 3.2: Reduced illegal logging

Description:

The project option of reducing forest degradation from illegal logging is particularly relevant to areas along rivers and roads.

Possible interventions to prevent illegal logging in a defined project area include:

- Option 3.1: Increasing law enforcement, surveillance and patrols and specifically targeting mostly commercial informal operators (who are usually not from the area even if they work with local intermediaries).
- Option 3.2: Engaging with community leaders and local administration that until now are tolerating illegal logging or are even complicit. This may involve creating alternative legitimate income sources and could potentially include legal, planned commercial logging or even "community forestry" (differentiate from "communal forestry").

Feasibility:

The feasibility of an intervention focused on avoided illegal logging faces many technical and methodological obstacles. The socioeconomic forces driving illegal logging in the landscape are believed to be quite strong; however, little is known about the extent of illegal logging, and how communities participate and the economic benefits that are derived locally. A broader study is needed in order to be able to realistically assess such a scenario and the ability of a carbon project to address the threat.

At a very basic level, some level of surveillance and patrolling should realistically be able to counter some of the illegal logging threats. However, given that most operators are not local and the real extent of the problem is not known, it is hard to assess whether interventions like alternative livelihood could really combat such pressure.

Methodologically, developing a carbon project around this threat is also difficult. No draft or approved methodology currently exists to capture the case of reduced or avoided illegal logging. Being unplanned forest degradation, this would most likely fall in the REDD (rather than IFM) category because of its non-formalised and non-planned nature. However, because of the great difficulty in quantifying location and impacts of illegal exploitation, and therefore projecting plausible quantified timber removals and collateral damage, it is questionable whether such methodologies will be forthcoming any time soon. Monitoring of project performance would be another challenge in this context.

It is important to note however that such interventions are difficult to frame within formal methodological approaches of existing voluntary market standards. Furthermore, delimiting the area of intervention that is amenable to monitoring and would not just result in leakage could also be a challenge.

Potential Impact:

Hence, the feasibility of a project is quite low at this point. Nonetheless, illegal logging is a very real threat in the landscape and understanding the nature of the activities would help inform future interventions with communities. Therefore additionality of emission reductions seems to be given and measures to reduce illegal logging would also lead to reducing the non-permanence risk of emission reductions from deforestation and forest degradation.

A study on the subject is highly recommended as a future step in order to determine the potential for emission reductions and the necessary measures to address the problem. For the current feasibility assessment, emissions and emission reductions from reduced illegal logging in the landscape have not been considered, neither in the baseline scenario (cf. section 5), nor in the different project scenarios presented in the following sections.

Conclusion:

Reducing illegal logging is unfeasible as a project option; however, understanding and addressing this source of emissions could be part of a number of project scenarios. In particular, MRV and law enforcement interventions could be structured to address sources of emissions from illegal logging as part of a broader landscape planning exercise and/or monitoring system.

6.2 REDD Project Scenarios

Under the previous section we have estimated the overall efficiency of different REDD project options in reducing deforestation and forest degradation in the Takamanda-Mone Landscape. In the present section, we will combine project options into three project scenarios and evaluate their potential for generating emission reductions. The emission reductions of a project scenario are equal to the difference between the baseline emissions and the project emissions minus emissions due to leakage as expressed by the following equation:

$$C_{REDD,t} = \Delta C_{BSL,t} - \Delta C_{P,t} - \Delta C_{LK,t} \qquad (8)$$

Where:

$C_{REDD,t}$	=	Total net greenhouse emission reductions at time t; t CO_2-e
$\Delta C_{BSL,t}$	=	Net greenhouse gas emissions under the baseline scenario at time t; t CO_2-e
$\Delta C_{P,t}$	=	Net greenhouse gas emissions within the project area under the project scenario at time t; t CO_2-e
$\Delta C_{LK,t}$	=	Net greenhouse gas emissions due to leakage at time t; t CO_2-e
t	=	1, 2, 3, … t years elapsed since the start of the REDD

As the evaluated project scenarios do not necessarily include all forests in the project area, the baseline emissions ($\Delta C_{BSL,t}$) estimated in section 5.4 for the entire Takamanda-Mone landscape will not apply to all proposed project scenarios. An emission baseline has therefore to be developed separately for each evaluated project scenario.

Similarly, $\Delta C_{P,t}$ and $\Delta C_{LK,t}$ are not yet known and therefore have to be estimated based on the expected reductions in deforestation and/or forest degradation in the project area according to the efficiency of the project options presented in the previous sections. As mentioned earlier, leakage is not quantified but rather integrated in the determination of the overall efficiency of each considered project scenario.

In the following section we evaluate the following steps for the three project scenarios:

- Describe the project scenario and the different REDD options it includes.
- Present spatially which forests would be included in the project area of each scenario.
- Estimate the baseline emissions under each scenario based on the results of the baseline development for the wider project region (cf. section 5.2).
- Assess the project emissions based on the expected efficiency of the REDD options that are included in the scenario.
- Evaluate the potential emission reductions by comparing the baseline emissions over the entire project period with the project emissions for the same period.

6.2.1 Scenario 1: Protection Scenario

Scenario 1, the Protection Scenario, focuses on the creation and sustainable management of protected areas as the principal REDD strategy in the Takamanda-Mone Landscape. The scenario focuses:

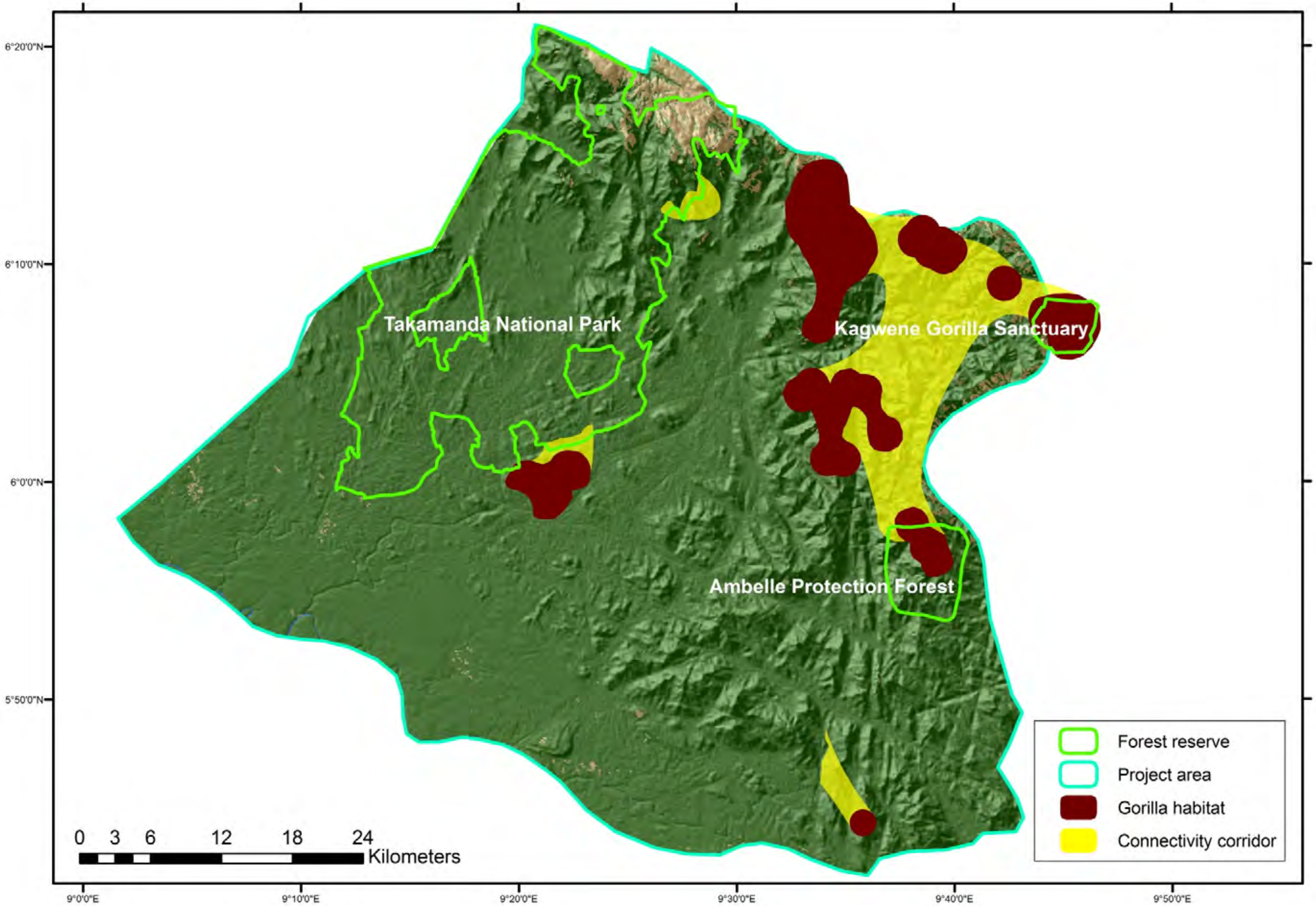
- Technically on reducing unplanned deforestation by creating new or extending existing protected areas and on reducing emissions from planned deforestation by converting logged to non-logged forest.
- Spatially on areas in the landscape that are already under protection status or have a high biodiversity conservation value (based on what is currently known).
- Institutionally,, the forest administration remain the owner and manager of the existing protected area network, with the possibility of NGOs and even local communities as potential co-managers or delegated managers.

6.2.1.1 Description

The scenario would consist in a combination of the following REDD options:

- New Protection Areas, option 1.3 (c.f. section 6.1.1.3): Reducing emissions from unplanned deforestation through the creation of new protected areas in the landscape and the improved management of existing ones, taking into account conservation objectives and connectivity aspects to identify areas to be protected in a process integrating local communities and other local and national stakeholders.
- Avoided legal logging, option 2.2 (c.f. section 6.1.2.2): Reducing emissions from planned forest degradation through conversion of logged forest to non-logged forest. Conservation areas in already existing (FMU 11004) or planned future concessions (Mone Forest Reserve) would be identified through a landscape-wide integrated process.
- Community-based forest management, option 1.2 (c.f. section 6.1.1.2) could serve as a means for transferring management of certain conservation areas to local communities but with restriction to non-extractive use.
- Improved agricultural production, option 1.1 (c.f. section 6.1.1.1) could be implemented to reduce leakage.
- Reduced illegal logging through improved law enforcement, option 3.1, (c.f. section 6.1.3) could potentially be included in this scenario, it is however not clear if potential emission reductions would be significant.

Figure 14: Project area for scenario 1



The project area under scenario 1 would include all forests that are inside a network of biodiversity conservation areas (protected areas, connectivity corridors, etc.), as well as high conservation value areas inside existing and planned forest concessions (cf. figure 14). All other forests in the landscape would be excluded from the project area.

Regarding avoided deforestation, existing protected areas considered by this scenario are the Takamanda National Park, Ambelle Protection Forest and the Kagwene Gorilla Sanctuary. There might be some additionality issues with integrating Takamanda National Park and Kagwene Gorilla Sanctuary into this network, unless it can be demonstrated that forest conservation in these parks would not be possible without revenues from emission reductions. This seems likely as income from other sources such as tourism and bilateral funding will probably not be sufficient for ensuring long-term management of the park (cf. figure 14).

For identifying the potential new protection areas, the Cross River gorilla habitats and connectivity corridors presented in section 3 have been used to determine the area that would be affected by this scenario and would therefore be part of the project area. These high conservation value areas cover an estimated 40'000 ha of forest outside areas that are potentially interesting for harvesting, mainly in the remote Mbulu Mountains to the north of Mone Forest Reserve.

Regarding reductions of emissions from planned forest degradation, only Mone Forest Reserve and FMU 11004 can be included into the project area because harvesting is already ongoing or plans for new concessions are quite concrete. Areas for potential harvesting under community-based forest management are excluded from the project because plans for creating these community-managed forests are not advanced enough to justify this intervention.

Because of a certain lack of data on biodiversity in the south of the Takamand-Mone landscape, the exact areas inside Mone Forest Reserve and FMU 11004 could not be spatialized. Instead we assumed that 20% of forests planned to be logged under concessions would be excluded from logging for biodiversity conservation concerns over the 20-year project period.

Takamanda National Park is the biggest and most recent protection area in the landscape and it seems therefore appropriate that the year of its creation, 2008, would be the start date for the project. However, the project could also start with the launching of the process leading to the delimitation of the areas constituting the biodiversity conservation network in the landscape. For the current feasibility assessment a project start date in 2010 has been chosen and a minimum project period of 20 years.

6.2.1.2 Baseline emissions under scenario 1

Estimation of baseline emissions under scenario 1 have been conducted separately for deforestation and for forest degradation.

Baseline emissions from unplanned deforestation:

Estimation of baseline emissions from unplanned deforestation was based on the same methodology as presented in sections 5.1 and 5.2 for the wider project region:

- The annual area of unplanned deforestation has been estimated by overlying the deforestation projections developed for the entire reference area over the specific project area for scenario 1 presented in figure 14. As deforestation projections have been made for five-year periods and not annually, we divided this value by five to determine the annual areas of baseline deforestation. The resulting annual area increases steadily from 68 ha per year at the beginning to 146 ha towards the end of the project period.

- Annual baseline emissions from unplanned deforestation have then been estimated by multiplying the annual area of baseline deforestation with the corresponding emission factors from table 10. As for the project region, it was assumed that 65% of deforestation would happen in relatively degraded forests that are easier to access by deforestation agents. Hence we use the following emission factors:
  - 65% of the area would be converted from degraded forest to cropland with an emission factor of 398.75 tCO_2-e/ha
  - the remaining 35% of deforestation are expected to occur in more difficult to access intact forest with higher carbon stocks and thus use the emission factor of intact forest to cropland of 525.99 tCO_2-e/ha.

Baseline emissions from planned forest degradation:

The estimation of baseline emissions from forest degradation was based on the methodology presented in section 5.3

- As mentioned above, we used a 20% approximation of the area set aside in concessions. This results in a total area of 8,040 ha or 402 ha per year.
- Based on this estimate, annual emissions from forest degradation can be calculated by multiplying the annual area of planned forest degradation with the corresponding emission factor. As it can be assumed that logging activities would happen mostly in intact forests and no FSC certified harvesting is expected to occur in the baseline, the emission factor for intact forest to conventionally logged forest of 40.16 t_{CO2}-e/ha has been used.

Baseline emissions from unplanned deforestation and planned forest degradation under scenario 1 estimated with this methodology are presented separately for each year of the project period in table 16.

Table 16: Estimated baseline emissions in the project area under scenario 1 for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	30,300	16,120	46,420	2021	56,024	16,120	72,144
2012	30,300	16,120	46,420	2022	56,024	16,120	72,144
2013	30,300	16,120	46,420	2023	56,024	16,120	72,144
2014	30,300	16,120	46,420	2024	56,024	16,120	72,144
2015	30,300	16,120	46,420	2025	56,024	16,120	72,144
2016	43,349	16,120	59,469	2026	64,833	16,120	80,953
2017	43,349	16,120	59,469	2027	64,833	16,120	80,953
2018	43,349	16,120	59,469	2028	64,833	16,120	80,953
2019	43,349	16,120	59,469	2029	64,833	16,120	80,953
2020	43,349	16,120	59,469	2030	64,833	16,120	80,953
				Total	**972,530**	**322,400**	**1,294,930**

6.2.1.3 Project emissions under scenario 1

The project emissions under scenario 1 are the emissions that are expected to occur in the project area described above if the different options of scenario 1 would be implemented. The project emissions from deforestation and forest degradation under scenario 1 are presented in table 17 based on the following assumptions for unplanned deforestation and planned forest degradation.

Project emissions from unplanned deforestation:

Project emissions from unplanned deforestation have been estimated using the following assumptions based on the analysis of the different REDD options in the previous section:

- Emission reductions from avoided unplanned deforestation could only be accounted for in the existing protected areas, mainly in Takamanda National Park, Ambelle protection forest and maybe Kagwene Gorilla sanctuary, as well as in the potential new protected areas in the Mbulu Mountains.
- Based on the reflections on the potential efficiency of the REDD option regarding creation and management of protected areas in section 6.1, it has been assumed that the related measures would reduce emissions from unplanned deforestation in the above mentioned areas by 75%.

Project emissions from planned forest degradation:

The estimation of project emissions from forest degradation was based on the following assumptions:

- Under this scenario, only emission reductions from avoided planned forest degradation in Mone forest reserve or FMU 11004 can be accounted for as these are the only areas where harvesting is already happening or planned to happen in the close future.
- Based on the expected efficiency of this measure it has been assumed that the exclusion of certain high conservation value forests inside existing and planned new concessions would reduce emissions from planned forest degradation by about 75%.

Table 17: Estimated project emissions in the project area under scenario 1 for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	7,575	4,030	11,605	2021	14,006	4,030	18,036
2012	7,575	4,030	11,605	2022	14,006	4,030	18,036
2013	7,575	4,030	11,605	2023	14,006	4,030	18,036
2014	7,575	4,030	11,605	2024	14,006	4,030	18,036
2015	7,575	4,030	11,605	2025	14,006	4,030	18,036
2016	10,837	4,030	14,867	2026	16,208	4,030	20,238
2017	10,837	4,030	14,867	2027	16,208	4,030	20,238
2018	10,837	4,030	14,867	2028	16,208	4,030	20,238
2019	10,837	4,030	14,867	2029	16,208	4,030	20,238
2020	10,837	4,030	14,867	2030	16,208	4,030	20,238
				Total	**243,130**	**80,600**	**323,733**

6.2.1.4 Potential emission reductions from scenario 1

Equation (8) has been used to estimate potential emission reductions from avoided unplanned deforestation in the described protection areas and from avoided planned forest degradation in the identified concessions. Leakage from activity displacement has not been considered because it is assumed that the successful implementation of measures improving agricultural production and livelihoods in areas adjacent to the project area would reduce the leakage potential considerably.

Results are presented separately for each year of the entire project period in table 18. They show that under scenario 1, emissions from unplanned deforestation and planned forest degradation in the described project area would be reduced by almost one million tons CO_2-e over the entire project period, with annual emission reductions of 35,000 to 60,000 tCO_2-e per year.

The feasibility of this scenario is quite low because most of the important biodiversity areas areas are located where historic deforestation is very low. The inclusion of Takamanda National Park would be crucial as this seems to be an area where historic deforestation was relatively high compared to other areas such as Mone Forest Reserve. A possible exception are connectivity corridors between Mone Forest Reserve and Takamanda National Park that would have to include areas along the existing and planned new road where deforestation is expected to increase significantly under the baseline scenario.

The feasibility of avoided logging also seems to be relatively low mainly because due to political resistance. This is particularly the case for Mone Forest Reserve, where local as well as national stakeholders seem to be opposed to creating conservation concessions for protecting some of the Cross River gorilla habitats.

It is thus expected that the proposed scenario will significantly reduce emissions from deforestation and forest degradation, but as these emissions seem to be quite low in the identified areas in the baseline scenario the overall reduction potential appears to be relatively low. Though protection can be a good option for REDD in general, for the Takamanda-Mone landscape the low emissions and political opposition mean that this scenario is likely not feasible as an option on its own.

Table 18: Estimated emission reductions under scenario 1 for the entire project period

Year	Baseline Emissions [t CO_2-e]	Project Emissions [t CO_2-e]	Emission Reductions [t CO_2-e]	Year	Baseline Emissions [t CO_2-e]	Project Emissions [t CO_2-e]	Emission Reductions [t CO_2-e]
2011	46,420	11,605	34,815	2021	72,144	18,036	54,108
2012	46,420	11,605	34,815	2022	72,144	18,036	54,108
2013	46,420	11,605	34,815	2023	72,144	18,036	54,108
2014	46,420	11,605	34,815	2024	72,144	18,036	54,108
2015	46,420	11,605	34,815	2025	72,144	18,036	54,108
2016	59,469	14,867	44,602	2026	80,953	20,238	60,715
2017	59,469	14,867	44,602	2027	80,953	20,238	60,715
2018	59,469	14,867	44,602	2028	80,953	20,238	60,715
2019	59,469	14,867	44,602	2029	80,953	20,238	60,715
2020	59,469	14,867	44,602	2030	80,953	20,238	60,715
				Total	**1,294,930**	**323,733**	**971,198**

6.2.2 Scenario 2: Sustainable Management

Scenario 2 concentrates on reducing emissions from deforestation and forest degradation through implementing measures for sustainable use of forest resources in the Takamanda-Mone landscape. As such, the scenario would focus:

- Technically on reducing unplanned deforestation by developing community management zones and reducing planned forest degradation by supporting the implementation of improved forest management techniques in forests managed mainly for sustainable production by concessionaires and local communities.
- Spatially on areas in the landscape already under concession or planned to be harvested or are at least interesting for sustainable forest management under community based management.
- Institutionally on the forest administration as owner and manager of the forests in the non-permanent forest domain and local communities and logging companies as current or potential future delegated managers of production forests in the landscape.

6.2.2.1 Description

Regarding the approach for reducing emissions from deforestation and forest degradation, scenario 2 combines the following REDD options:

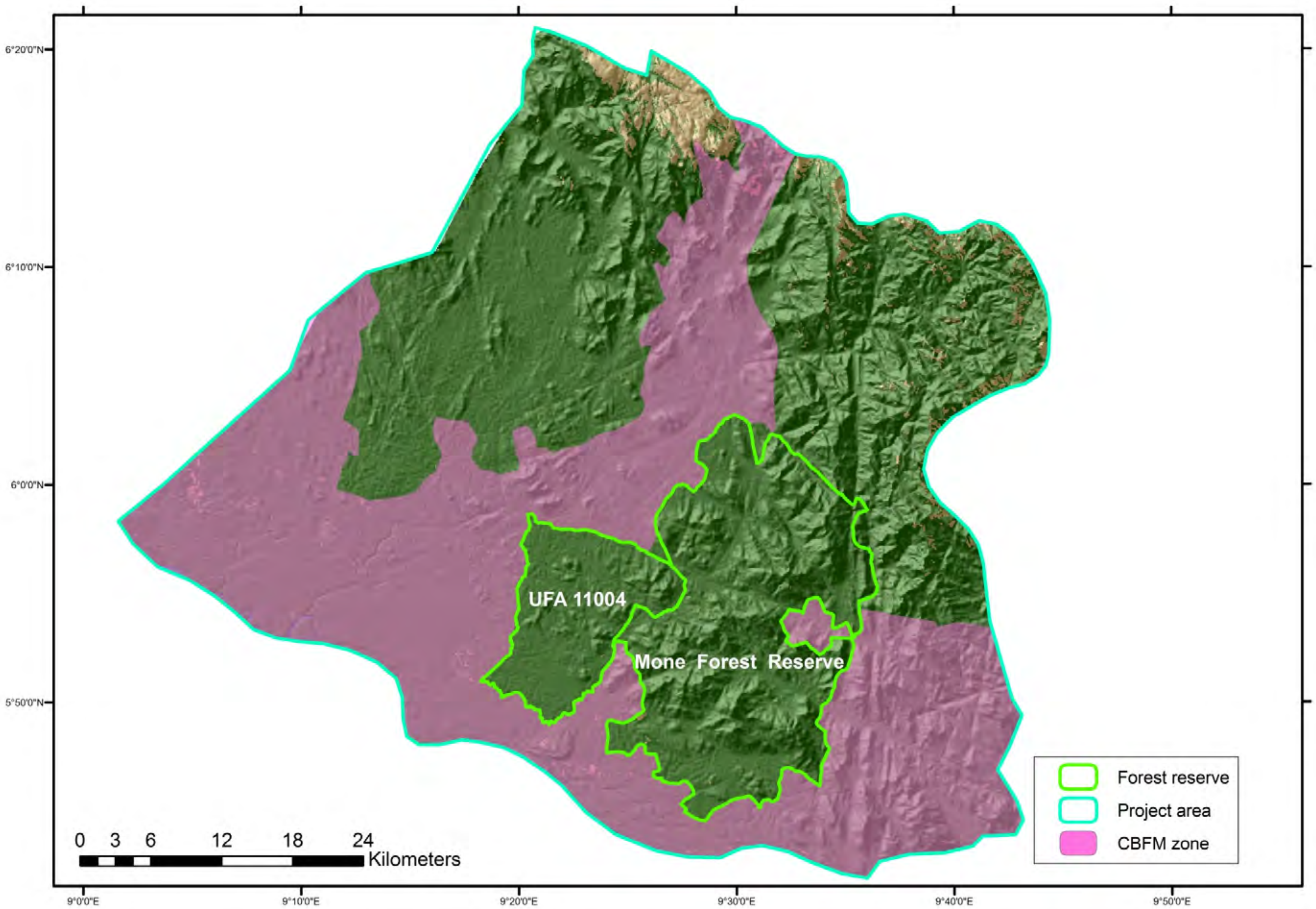
- Community-based forest management, option 1.2 (c.f. 6.1.1.2): In areas that are not under concession this would involve transferring forest management rights to local communities and councils and building their institutional and technical capacities for sustainable forest management and engaging with local communities in order to achieve agreed limitations for expanding community agriculture areas.
- Improved legal logging, option 2.1 (c.f. 6.1.2.1): This would be implemented in current and future logging concessions as well as in community and council forests that would be created. A possible option would be to require that these companies comply with FSC standards after a certain number of years of operation.
- Improved agricultural production in already deforested areas, option 1.1 (c.f.6.1.1.1) could be used to mitigate leakage from activity displacement provoked by the REDD measures.
- Reduced illegal logging, option 3.2 (c.f. 6.1.3) could be included in this scenario as well but would not generate emission reductions.

The project area for scenario 2 would include all forests in the landscape at project start that already are or could potentially be put under some form of sustainable management. This would obviously include FMU 11004 and Mone Forest Reserve as well as other forests in the landscape that are potentially interesting for sustainable use by local communities, councils and/or private operators.

In addition, the avoided deforestation component would include all forests that are to be put under sustainable forest management, either by local communities through management transfer (community and/or council forests) or by private operators. This includes Mone Forest Reserve, FMU 11004, as well as the forests that seem to be interesting for sustainable harvesting by local communities or other actors (cf. figure 15). These forests potentially managed sustainably by local communities or other actors does however not include all forests currently under no particular management, mainly because some of the forests in the non-permanent domain do not seem to be interesting for production forestry.

Inclusion of FMU 11004 into the project area for avoided deforestation could raise some additionality issues because this area is already under sustainable management by the company TRC and it might be difficult to demonstrate that revenue from emission reductions are essential for preventing deforestation.

Figure 15: Project area for scenario 2



The areas for potential future sustainable harvesting by local communities or other operators have been spatialized based on the assumption that these would be concentrated in relatively flat areas in the southern part of the landscape and between Takamanda National Park and Mone Forest Reserve. Forests to the north of Mone Forest Reserve and in the Mbulu Mountains have not been included in the project area of scenario 2 because they are very difficult to access and have extreme relief which means that harvesting them would not be very attractive.

Regarding reductions of emissions from planned forest degradation, Mone Forest Reserve and FMU 11004, have to be included into the project area (cf. figure 15). Reduced degradation in areas for potential harvesting under community based forest management could however not be integrated because there is currently no concrete plan for delegating management authority to local communities, councils or other actors in the area.

The project start for avoided deforestation would be chosen to coincide with the start of a planning process to form new sustainably managed areas with communities (or later). For avoided degradation, the project would begin upon introduction of RIL techniques.

6.2.2.2 Baseline emissions under scenario 2

Baseline emissions under scenario 2 have been estimated separately for deforestation and for forest degradation.

Baseline emissions from unplanned deforestation:

- The same methodology described in the previous section was used to estimate areas of unplanned deforestation. Annual averages for the four modelled five-year periods have been used resulting in annual areas of baseline deforestation ranging from 657 ha at the beginning to 721 ha at the end of the 20-year project period.

Table 19: Estimated baseline emissions in the project area under scenario 2 for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	291,267	80,601	371,868	2021	307,633	80,601	388,234
2012	291,267	80,601	371,868	2022	307,633	80,601	388,234
2013	291,267	80,601	371,868	2023	307,633	80,601	388,234
2014	291,267	80,601	371,868	2024	307,633	80,601	388,234
2015	291,267	80,601	371,868	2025	307,633	80,601	388,234
2016	313,501	80,601	394,102	2026	319,593	80,601	400,194
2017	313,501	80,601	394,102	2027	319,593	80,601	400,194
2018	313,501	80,601	394,102	2028	319,593	80,601	400,194
2019	313,501	80,601	394,102	2029	319,593	80,601	400,194
2020	313,501	80,601	394,102	2030	319,593	80,601	400,194
				Total	**6,159,970**	**1,612,020**	**7,771,990**

- Calculation of annual baseline emissions from unplanned deforestation by multiplying areas with appropriate emissions factors. It is assumed that 65% of deforestation would occur in forests already degraded by logging and/or agroforestry (emission factor 398.75 tCO_2-e/ha), and only 35% of unplanned deforestation would occur in more difficult to access intact forest (emission factor 525.99 tCO_2-e/ha).

Baseline emissions from planned forest degradation:

Annual emissions from planned forest degradation caused by legal logging under scenario 2 have been estimated in a way similar to the estimates made in section 5.3 for the wider project region:

- Baseline forest degradation focused on the areas of existing and planned concessions, namely Mone Forest Reserve and FMU 11004. As forest management in Cameroon usually uses a 30-year rotation time between harvesting, the total area has been divided by 30 in order to calculate the annual area of 2,007 ha of planned forest degradation.
- The annual area is then multiplied with the emission factor for conventional logging: 40.16 tCO_2-e/ha. This emission factor was used because it is not expected that FSC certified or other low impact techniques would be implemented in absence of a REDD project in the landscape.

Estimated baseline emissions from deforestation and forest degradation in the project area under scenario 2 are presented separately for each year of the project period in table 19 above.

6.2.2.3 Project emissions under scenario 2

The project emissions under scenario 2 are the emissions that are expected to occur in the project area if all the measures related to the REDD options integrated into scenario 2 would be implemented in and around the project area. Again these emissions can be estimated indirectly by estimating the impact of the proposed measures on deforestation and forest degradation in the appropriate parts of the project area.

Table 20: Estimated project emissions in the project area under scenario 2 for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	145,634	40,301	185,934	2021	153,817	40,301	194,117
2012	145,634	40,301	185,934	2022	153,817	40,301	194,117
2013	145,634	40,301	185,934	2023	153,817	40,301	194,117
2014	145,634	40,301	185,934	2024	153,817	40,301	194,117
2015	145,634	40,301	185,934	2025	153,817	40,301	194,117
2016	156,751	40,301	197,051	2026	159,797	40,301	200,097
2017	156,751	40,301	197,051	2027	159,797	40,301	200,097
2018	156,751	40,301	197,051	2028	159,797	40,301	200,097
2019	156,751	40,301	197,051	2029	159,797	40,301	200,097
2020	156,751	40,301	197,051	2030	159,797	40,301	200,097
				Total	**3,079,985**	**806,010**	**3,885,995**

Project emissions from unplanned deforestation:

Project emissions from unplanned deforestation have been estimated using the following assumptions based on the analysis of the different REDD options in the previous section:

- Under scenario 2, emission reductions could only be accounted for in the existing (FMU 11004) and planned (Mone Forest Reserve) concessions as well as in the areas that are potentially interesting for sustainable management by local communities, councils and/or logging companies.
- A 50% reduction for implementation of sustainable forest management system is assumed.

Project emissions from planned forest degradation:

The estimation of project emissions from forest degradation was based on the following assumptions regarding the proposed implementation of measures reducing the impact of harvesting operations on carbon stocks:

- As mentioned above, scenario 2 focuses on FMU 11004 as well as on Mone Forest Reserve and the main measure for achieving emission reductions is the implementation of improved logging techniques.
- It has been assumed that the implementation of these measures would reduce emissions from planned forest degradation by about 50%. This parameter was deduced from comparing the emission factor for conventional logging (40.16 tCO_2-e/ha) with that for improved or FSC logging (22.74 tCO_2-e/ha).

Application of these assumptions and parameters resulted in the project emissions from deforestation and forest degradation under scenario 2 presented in table 20.

6.2.2.4 Potential emission reductions from scenario 2

Equation (8) has been used to estimate potential emission reductions from avoided unplanned deforestation in the sustainable management areas and from avoided planned forest degradation in

Table 21: Estimated emission reductions under scenario 2 for the entire project period

Year	Baseline Emissions [t CO_2-e]	Project Emissions [t CO_2-e]	Emission Reductions [t CO_2-e]	Year	Baseline Emissions [t CO_2-e]	Project Emissions [t CO_2-e]	Emission Reductions [t CO_2-e]
2011	371,868	185,934	185,934	2021	388,234	194,117	194,117
2012	371,868	185,934	185,934	2022	388,234	194,117	194,117
2013	371,868	185,934	185,934	2023	388,234	194,117	194,117
2014	371,868	185,934	185,934	2024	388,234	194,117	194,117
2015	371,868	185,934	185,934	2025	388,234	194,117	194,117
2016	394,102	197,051	197,051	2026	400,194	200,097	200,097
2017	394,102	197,051	197,051	2027	400,194	200,097	200,097
2018	394,102	197,051	197,051	2028	400,194	200,097	200,097
2019	394,102	197,051	197,051	2029	400,194	200,097	200,097
2020	394,102	197,051	197,051	2030	400,194	200,097	200,097
				Total	**7,771,990**	**3,885,995**	**3,885,995**

the identified concessions. Leakage has not been considered and results are presented for the entire project period in table 21. They show that under scenario 2, emissions from unplanned deforestation would be reduced by 3,079,985 tCO_2-e over the entire project period, while emissions from planned forest degradation would be reduced by 806,010 tCO_2-e over 20 years, resulting in total emission reductions of 3,885,995 tCO_2-e over the project period or 194,300 tCO_2-e per year.

The potential of scenario 2 to reduce emissions from unplanned deforestation seems to be quite high, mainly because in the areas for implementing community based forest management the deforestation risk seems to be relatively high and also related to a relatively high emission factor. This is also the case for FMU 11004, but additionality issues could prevent a future REDD project from accounting for emission reductions in this area.

The potential for reducing emissions from planned forest degradation seem to be quite low, essentially due to the small difference in emission factors between conventional and improved logging. Already at present, harvesting activities are selective and their impact on carbon stocks is limited, which reduces the potential for reducing emissions of the proposed option. Another problem is the fact that reductions from planned forest degradation cannot be accounted for in the community-managed forests because their creation is not really planned for the moment.

There seems to be a certain risk of leakage through the displacement of deforestation activities to outside the project area and it is important to implement appropriate mitigation measures in non-forested areas inside and around the project area. The risk of leakage related to forest degradation seems to be relatively low for improved legal logging because RIL measures usually have very low impact on the harvestable volumes.

Non-permanence risks seem to be quite high, mainly due to the fact that community forests would not be part of the permanent forest domain, although the development of a sustainable management for these forests is mandatory. However, these risks could be reduced by integrating the community forests into a landscape wide land use plan as mentioned above.

6.2.3 Scenario 3: Integrated Land Use Approach

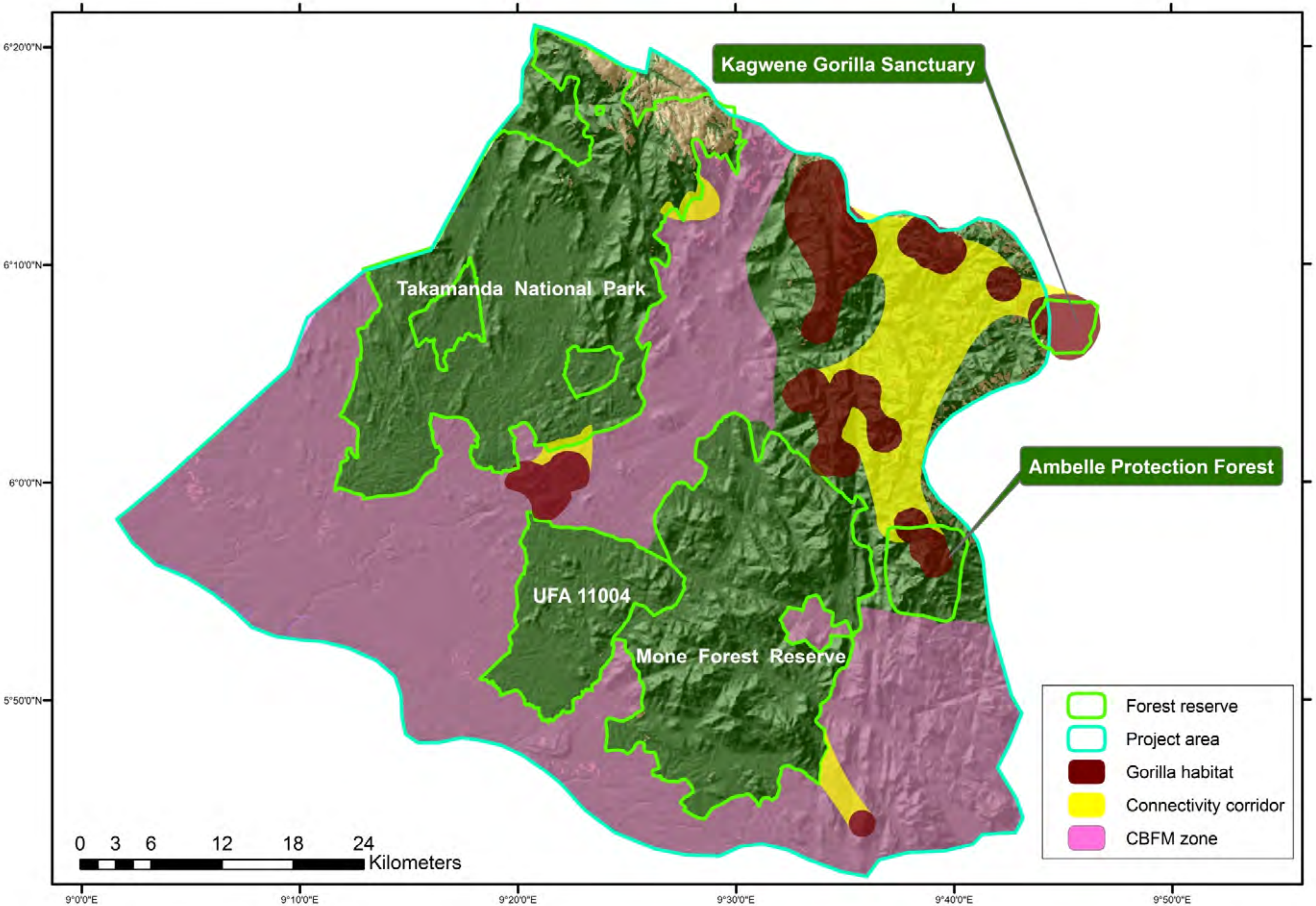
Scenario 3 is an integrated scenario, combining scenarios 1 and 2 discussed above, and would be focused:

- Technically on reducing unplanned deforestation by developing community management zones as well as creating new or extending existing protected areas, and on reducing planned forest degradation by supporting the implementation of improved forest management techniques in forests managed mainly for sustainable production by concessionaires and local communities, and avoided planned forest degradation by supporting the creation of set asides in concessions.
- Spatially on all forests in the landscape corresponding with the project region defined in section 4.1.
- Institutionally on the forest administration as owner and manager of the forests in the non-permanent forest domain and local communities, NGOs and logging companies as current or potential future delegated managers of production and protection forests in the landscape.

6.2.3.1 Description

Scenario 3 is a combination of the REDD options in scenarios 1 and 2 and the zones considered in the scenario are represented in figure 16.

Figure 16: Project area for scenario 3



6.2.3.2 Baseline Emissions under scenario 3

The estimates for baseline emissions from section 5.4 can directly be used for this scenario, given the inclusiveness of the scenario. Additionality and other issues regarding the inclusion in the project of certain areas in the landscape (i.e. Takamanda National Park) have already been discussed in the sections on scenarios 1 and 2. One should note however that by including all different sources of emissions and lumping them together the feasibility of certain aspects might increase. For example RIL in concession may be more feasible in the context of a larger project that includes set asides and community management in the buffer zones. Similarly set asides, park creation, connective corridors may become more politically feasible when weighed along with other interventions.

Estimated baseline emissions from deforestation end forest degradation under scenario 1 are presented separately for each year of the project period in table 22.

6.2.3.3 Project emissions under scenario 3

Scenario 3 combines different activities to reduce emissions from deforestation and forest degradation. In areas of high biodiversity value, interventions would focus on reducing destructive uses of forest resources through the creation of protection zones, the development of conservation contracts with local communities and the creation of conservation concessions with logging operators (as outlined in scenario 1). In zones designated for sustainable use, interventions would be oriented towards empowering local communities and councils, building their capacities in forest management and implementation of improved forest management techniques. Measures to increase agricultural production would be implemented in non-forested areas inside and around the project region in order to reduce the risk for leakage. Measures to monitor and reduce illegal logging would also be integrated into this scenario as part of the development of MRV and control and vigilance systems.

Table 22: Estimated baseline emissions in the project area under scenario 3 for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	367,379	80,601	447,980	2021	400,480	80,601	481,081
2012	367,379	80,601	447,980	2022	400,480	80,601	481,081
2013	367,379	80,601	447,980	2023	400,480	80,601	481,081
2014	367,379	80,601	447,980	2024	400,480	80,601	481,081
2015	367,379	80,601	447,980	2025	400,480	80,601	481,081
2016	404,583	80,601	485,184	2026	419,489	80,601	500,090
2017	404,583	80,601	485,184	2027	419,489	80,601	500,090
2018	404,583	80,601	485,184	2028	419,489	80,601	500,090
2019	404,583	80,601	485,184	2029	419,489	80,601	500,090
2020	404,583	80,601	485,184	2030	419,489	80,601	500,090
				Total	**7,959,655**	**1,612,020**	**9,571,675**

A few assumptions used in the calculation of project emissions should be clarified:

- Avoided unplanned deforestation includes all areas that were included in the two previous scenarios. The same emission factors used for avoided deforestation in the two previous scenarios were used. Emission reductions are expected to be 75% for protection and 50% for sustainable forest management.
- Emission reductions from reduced planned forest degradation could be accounted for only in FMU 11004 and Mone Forest Reserve. In addition, we deducted 20% of the total area of these concessions, as we did in Scenario 1 for avoided logging which explains why the reduced degradation estimates are lower than in scenario 2. Reductions in the 20% set aside are the same as protection (75% of the baseline). Emission reductions from improved logging and management measures (80% of the area) would be only 50% of the baseline emissions.

The assumptions regarding the efficiency of the project activities have already been presented in the sections on scenario 1 and 2. Application of these assumptions and parameters resulted in the project emissions from deforestation and forest degradation under scenario 3 presented in table 23.

6.2.3.4 Potential emission reductions from scenario 3

Equation (8) has been used to estimate potential emission reductions from avoided unplanned deforestation in the described protection and sustainable management areas and from avoided planned forest degradation in the identified concessions. Leakage from activity displacement has not been considered because it is assumed that the successful implementation of measures improving agricultural production and livelihoods in areas adjacent to the project area would reduce the leakage potential considerably.

Table 23: Estimated project emissions in the project area under scenario 3 for the entire project period

Year	Emissions from Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]	Year	Emissions From Deforestation [t CO_2-e]	Emissions from Degradation [t CO_2-e]	Total Emissions [t CO_2-e]
2011	153,209	36,270	189,479	2021	167,823	36,270	204,093
2012	153,209	36,270	189,479	2022	167,823	36,270	204,093
2013	153,209	36,270	189,479	2023	167,823	36,270	204,093
2014	153,209	36,270	189,479	2024	167,823	36,270	204,093
2015	153,209	36,270	189,479	2025	167,823	36,270	204,093
2016	167,588	36,270	203,858	2026	176,005	36,270	212,275
2017	167,588	36,270	203,858	2027	176,005	36,270	212,275
2018	167,588	36,270	203,858	2028	176,005	36,270	212,275
2019	167,588	36,270	203,858	2029	176,005	36,270	212,275
2020	167,588	36,270	203,858	2030	176,005	36,270	212,275
				Total	**3,323,118**	**725,408**	**4,048,526**

Results are presented for the entire project period in table 24. They show that under scenario 3, total emissions from unplanned deforestation and planned forest degradation could be reduced by at least 5.5 million tons of CO_2-e over the entire project period, with an annual average emission reduction of more than 275,000 tCO_2-e/y.

Table 24: Estimated emission reductions under scenario 2 for the entire project period

Year	Baseline Emissions [t CO_2-e]	Project Emissions [t CO_2-e]	Emission Reductions [t CO_2-e]	Year	Baseline Emissions [t CO_2-e]	Project Emissions [t CO_2-e]	Emission Reductions [t CO_2-e]
2011	447,980	189,479	258,501	2021	481,081	204,093	276,988
2012	447,980	189,479	258,501	2022	481,081	204,093	276,988
2013	447,980	189,479	258,501	2023	481,081	204,093	276,988
2014	447,980	189,479	258,501	2024	481,081	204,093	276,988
2015	447,980	189,479	258,501	2025	481,081	204,093	276,988
2016	485,184	203,858	281,326	2026	500,090	212,275	287,815
2017	485,184	203,858	281,326	2027	500,090	212,275	287,815
2018	485,184	203,858	281,326	2028	500,090	212,275	287,815
2019	485,184	203,858	281,326	2029	500,090	212,275	287,815
2020	485,184	203,858	281,326	2030	500,090	212,275	287,815
				Total	**9,571,675**	**4,048,526**	**5,523,150**

7 Conclusions

In this section we compare the results obtained in the previous section and highlight potential future steps for REDD in the Takamanda-Mone landscape.

7.1 Discussion of outcomes of the feasibility study

The main outcomes of the feasibility study regarding feasibility and potential emission reductions of the three REDD project scenario are presented in figure 17 below. A more detailed discussion of quantitative (emission reductions) and qualitative (feasibility) aspects of the three scenarios is provided in the following two sections.

7.1.1 Feasibility

Although each of the scenarios outlined above has positive and negative aspects, in reality the integrated scenario 3 may be the most feasible. Firstly this scenario, scenario 3 generates the most emission reductions than any other. Secondly, because of its broad view of addressing different sources of emissions through a variety of options, it appeals to a broad group of stakeholders: conservationists, government, private sector and communities. Third, by taking a landscape approach, leakage is minimized, particularly in areas of high deforestation potential (such as around roads).

Moreover, increasingly international donors and policymakers are mandating that countries, like Cameroon, reduce emissions and monitor them at larger scale. In this light, an integrated approach to reducing emissions at a landscape level in Takamanda-Mone may serve as a model for other

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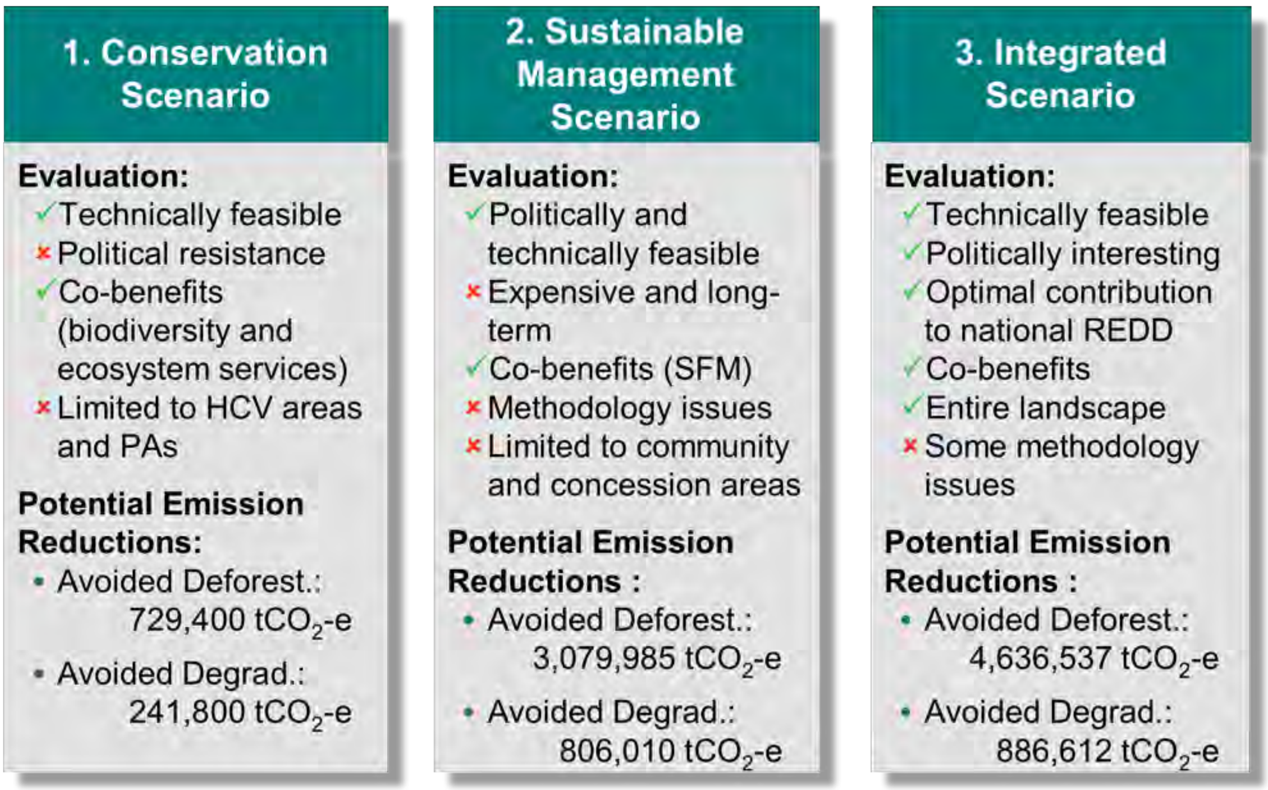
Figure 17: Feasibility and expected impact on GHG emissions of the three discussed REDD project scenarios



regions to design such program. In fact, scenario 3 contributes the most to Cameroon's national strategy not only by higher emission reductions, but also because it tests different approaches to a number of the main sources of emissions.

In this light, the Takamanda-Mone landscape is as an excellent microcosm of the threats facing Cameroon's forests and would serve as an ideal location for piloting activities to address multiple threats through a broader landscape planning process that reconciles the often competing goals of climate change mitigation, biodiversity conservation and local development.

7.1.2 Potential emission reductions

Regarding potential emission reductions, the present feasibility study provides the following estimates:

- **Scenario 1:**
  - Emission reductions from avoided deforestation: 729,400 tCO_2-e
  - Emission reductions from avoided forest degradation: 241,800 tCO_2-e
  - **Total emission reductions: 971,200 tCO_2-e**

- **Scenario 2:**
  - Emission reductions from avoided deforestation: 3,079,985 tCO_2-e
  - Emission reductions from avoided forest degradation: 806,010 tCO_2-e
  - **Total emission reductions: 3,885,995 tCO_2-e**

- **Scenario 3:**
  - Emission reductions from avoided deforestation: 4,636,537 tCO_2-e
  - Emission reductions from avoided forest degradation: 886,612 tCO_2-e
  - **Total emission reductions: 5,523,149 tCO_2-e**

Scenario 3 obviously shows the highest potential emission reductions, but it has to be noted that for a project the size of the Takamanda Mone landscape expected emission reductions appear to be relatively low for all three scenarios. It has however to be considered that the feasibility study was conservative in many aspects, mainly:

- Although the analysis of historic deforestation showed increasing rates of deforestation, estimation of annual areas of baseline deforestation used an average deforestation rate over the historic reference period. Using an increasing deforestation rate would be possible under most existing REDD project methodologies and could lead to a substantial increase of baseline emissions from deforestation and thus potential emission reductions.
- Carbon stocks have been established based on quite detailed forest inventories and are therefore considered relatively precise. However, these estimates do not include soil carbon and inclusion of this carbon pool could lead to a substantial increase in carbon stocks and thus to higher emission factors.
- The applied emission reductions of 50% for sustainable forest management and 75% for protection measures are considered relatively low. It is quite likely that in a real REDD project the proposed measures would have a more positive impact deforestation.

Consequently, the estimated emission reductions are to be considered as an absolute minimum and it is very likely that emission reductions in a real REDD project will be considerably higher, especially if the tendency of increasing deforestation rates in the Takamanda Mone landscape can be confirmed by a more detailed analysis.

7.1.3 Conclusions

Initiating a landscape-level planning process would not only set the pre-conditions necessary for minimizing impacts of these future developments, but also enable stakeholders to work together to develop a comprehensive plan to reduce emissions, protect biodiversity, and support local development in the area. Landscape-level planning process would include a number of different components:

- Outreach to local communities to map the demographics of the area, begin developing potential zoning arrangements, and initiate consultations
- Assess potential for community forest management building on the experience of GFA in the southern part of the landscape and the evaluation of steps for transfer of properties for counsel and community forest
- Build greater understanding of the biodiversity outside the park and potential impacts of improvement
- Evaluate zoning options for reducing future emissions and biodiversity impacts of new infrastructure improvements and leases through potentially different zones of protection
- Biomass inventory
- Support the creation of national REDD readiness process through support to policymakers, particularly in the areas of local consultations and the nesting of project-based activities in jurisdictional boundaries

Implementing this type of land use planning process requires significant upfront investment to establish the enabling conditions necessary for REDD. The cost of establishing such a process will not be offset through any one REDD project, but is a necessary precondition to zoning the landscape and will result in a more stable, participatory, effective process.

Figure 18: Proposed main components for the implementation of the integrated REDD project scenario 3

7.2 Recommendations for project implementation

In the following sections we provide some recommendations on the implementation of a REDD project based on scenario 3 in the Takamanda Mone Landscape. A general overview of the proposed implementation approach is given in figure 18.

7.2.1 Project goals and target groups

The implementation of the integrated scenario 3 described and discussed above would aim to contribute to national strategies for climate and biodiversity protection in Cameroon by mitigating greenhouse gas emissions and enhancing biodiversity conservation in the Takamanda Mone landscape through protection and sustainable forest management.

The overall project goal would be to contribute to the development of national strategies and implementation frameworks for climate and biodiversity protection in Cameroon by mitigating greenhouse gas emissions and enhance biodiversity conservation through protection and sustainable management of forest ecosystems in the Takamanda Mone Landscape. This would include the following more specific goals:

1. Strategies and measures for reducing deforestation from conversion of forestland to small-scale subsistence and commercial agriculture are tested.
2. Strategies and measures for reducing forest degradation from legal and illegal logging in the landscape are tested.
3. Areas with high conservation value in the landscape are identified and put under appropriate protection status.
4. New actors are identified and integrated into sustainable forest management and biodiversity conservation.
5. Project impacts and results are monitored and gained experiences inform national level climate and biodiversity protection strategy development.

Such a project would target the following stakeholders:

- Local communities in the landscape
- Government agencies: MINEP and MINFOF
- Logging companies

7.2.2 Project components and activities

According to the specific goals stated above, implementation of the Takamanda Mone integrated REDD project would follow the following five main components:

1. Reducing unplanned deforestation
2. Reducing planned and unplanned forest degradation from legal and illegal logging
3. Enhance biodiversity conservation
4. Support diversification of actors of sustainable forest management and conservation
5. Monitoring and outreach

The following sections provide some information on the project activities of each component that seem to be necessary to achieve the goals and results of such a project.

7.2.2.1 Component 1: Reducing deforestation

Expected results:

- Relevant data collected and methodological tools developed
- Broad land use strategy developed and validated by all stakeholders
- Agriculture systems improved

Proposed Activities:

- Collection of relevant data:
  - Consult with local communities to understand national REDD process and project goals and collect data on:
    - Social and governance analysis: How many people are really in the landscape; what do they do; what is their economic level (basic necessities); how are they organized; who are the important leaders; what is current land use systems in the landscape.
    - Economic analysis: opportunity costs; market analysis; in forest concessions; costs and income; market analysis of commodities coming into the landscape
    - Develop methodology for participatory mapping and initiate with pilot community and map population and economic data.
  - Detailed carbon Stock and Land use Change Assessment (to serve as foundation for the development of the regional emissions baseline):
    - Carbon stocks and forest resources through capitalizing existing data (research projects, logging concessions, etc.) and conducting new forest inventories in conjunction with national process.
    - Develop methodology for conducting historic land use analysis and measuring land use change to greater accuracy than feasibility study; identify potential techniques for measuring degradation.
    - Conduct a more detailed analysis of historic land use and land use change in the landscape which can be used to measure and monitor impact on forest.
  - Illegal logging: Conduct study on spatial and quantitative aspects of illegal logging in the landscape.
  - Assessment of potential impact of climate change on biodiversity, forest resources and agricultural production in the landscape.

- Development of integrated land use strategy:
  - Establish Takamanda Mone landscape stakeholder steering committee or platform to guide land use planning process, determine members and responsibilities, build capacities of members according to their responsibilities.
  - Develop methodology for integrating data into full land use strategy
  - Based on collected and existing data and information develop land use scenarios for the Takamanda Mone Landscape.
  - Launch consultation process on the developed scenarios with all stakeholders (local communities and councils, private sector, etc.)
  - Finalize land use strategy by spatializing main management objectives (production forest, protection forest, etc.).

- Improvement of agricultural production:
  - Identify strategies for improving agriculture and mitigating climate change through intensified agriculture, agroforestry and better access to markets
  - Evaluation of potential and structure for conservation payments as a way to increase income.

7.2.2.2 Component 2: Reducing forest degradation

Expected Results:

- IFM and RIL techniques defined and implemented in legally harvested forests
- Illegal logging reduced through improved law enforcement
- Alternative livelihoods based on sustainable forest management created

Proposed Activities:

- Development and implementation of Improved Forest Management and RIL techniques in forests managed for sustainable production:
  - Identify the most appropriate techniques for the different management systems in the landscape
  - Build capacities of actors
  - Implement activities

- Improvement of forest law enforcement:
  - Analyze the problem (land use strategy)
  - Develop law enforcement methodology (hot spots, collaboration with local communities, chain of custody system, etc.)
  - Material and technical support to actors to implement the law enforcement strategy.

- Development of alternative livelihoods:
  - Development of possible activities (local transformation of forest products, eco-tourism, etc.) with actors.
  - Capacity building.
  - Development of partnerships.

7.2.2.3 Component 3: Biodiversity conservation

Expected results:

- High conservation value forest areas are identified.
- Strategy to protect and manage HCVF put in place (i.e. a mixture of new protected areas, corridors; and community conservation management systems)

Proposed Activities:

- Biodiversity evaluation and High Conservation Value Assessment (integrated into land use plan development) to identify new areas of high conservation value, areas that can enhance connectivity, and develop strategies to protect these new areas. Potential strategies that will be considered are the creation of new protected areas, corridors, and alternative management opportunities such as community conservation management systems especially in the buffer zones of existing and new protected areas:

    - Conduct field assessment of biodiversity outside the park
    - Create methodology for HCVF mapping and prioritization
    - Map areas and look for connectivity and corridors with existing national parks

- Setting up of new protected areas:
    - Support creation of the new PAs, define status (Category) and support management delegation to local communities and/or local or international NGOs if necessary (not necessary if areas are inside concessions or community/council forests).
    - Support development of management and business plans for the new PAs.
    - Build capacities of PA managers in order to ensure implementation of management plans.

7.2.2.4 Component 4: Diversification of actors of forest management

Expected results:

- Delegated managers identified.
- Management of selected areas delegated to communities, councils and/or NGOs.
- Capacities of delegated managers improved

Proposed Activities:

- Support to delegation of forest management to local managers
- Development of community and/or council forests
- Support to bidding procedures for new concessions).
- Support to internal forest zoning (protection zones, production zones, plantation zones, restoration zones) in individual forest management units (community forests or concessions) for reducing emissions from deforestation.
- Support to development of forest management plans and particularly the integration of elements to reduce emissions from forest degradation.
- Technical support to implement techniques reducing emissions from forest degradation (RIL, improved transformation, etc.).

7.2.2.5 Component 5: Monitoring and outreach

Expected results:

- Systems for monitoring emission reductions and other impacts of the project developed and implemented
- Experience gained in the project feeds into national strategies on climate and biodiversity protection.
- Capacites of national and regional actors are improved

Proposed Activities:

- Development and implementation of monitoring systems:
    - Develop systems for monitoring carbon emissions and emission reductions in the landscape (activity data and carbon stock data)
    - Monitor impacts of the implemented measures on biodiversity and social aspects.

- Conduction of outreach activities:
  - Report regularly on results and methodologies with national REDD+ coordination.
  - Inscription of the project into the national REDD+ readiness preparation process.
  - Support development of national REDD+ project registry.

- Building of capacities of stakeholders:
  - Train national actors on REDD+ specific techniques (baseline development, MRV system, etc.)
  - Train actors on the implementation of the different measures to reduce emissions and protect biodiversity.

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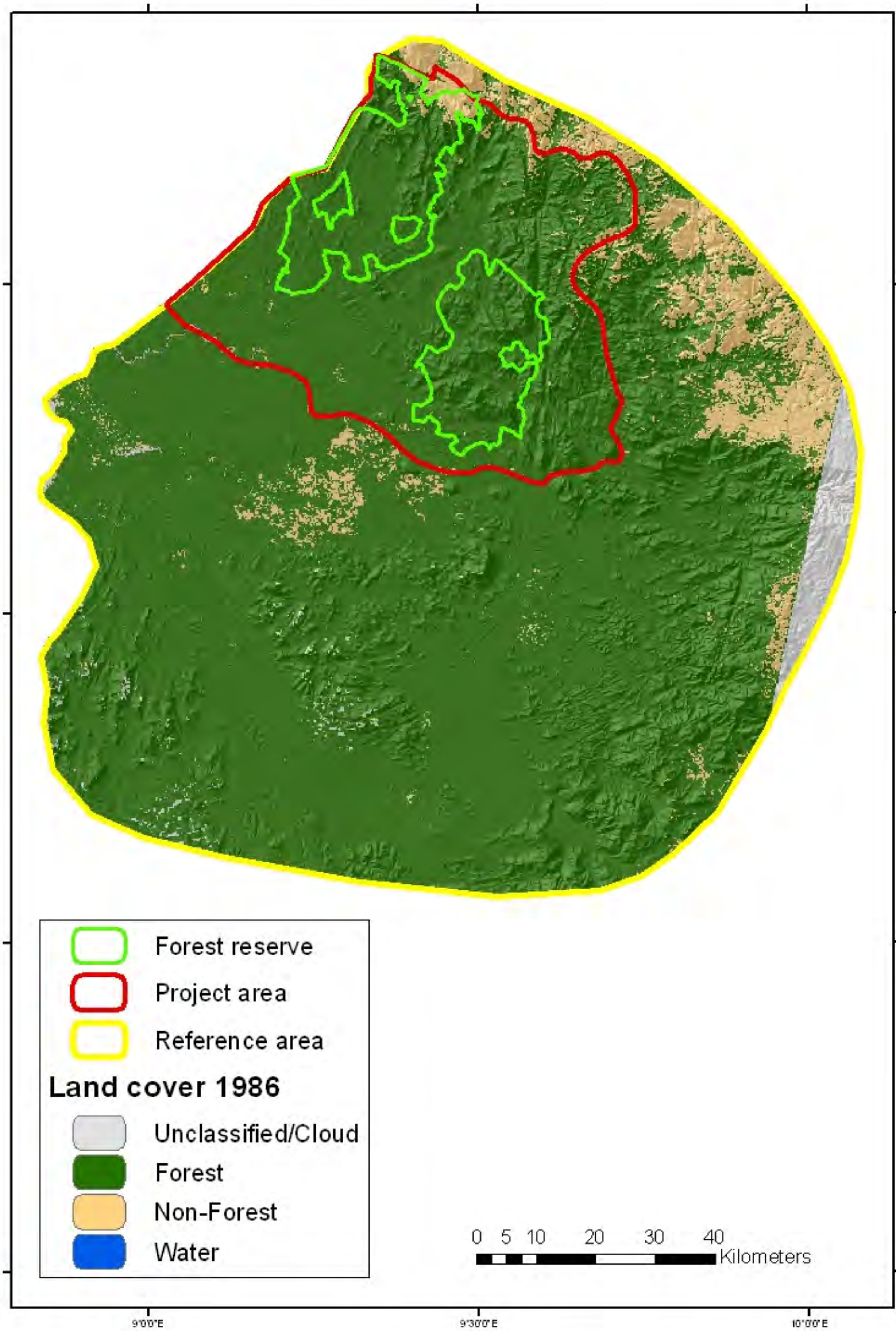
ANNEXES

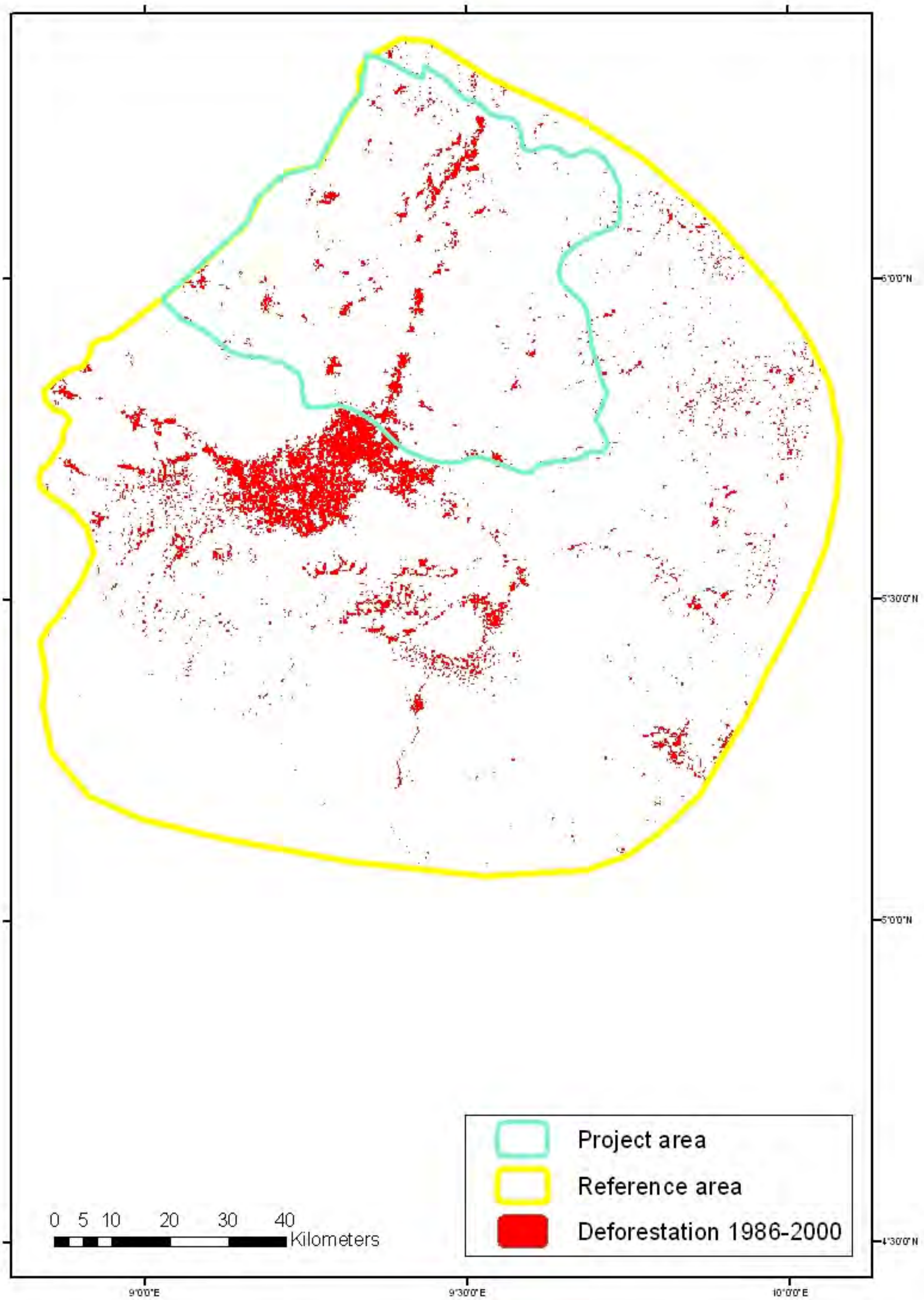
- Detailed Maps
- Conservation planning

Annex 1 : Detailed Maps

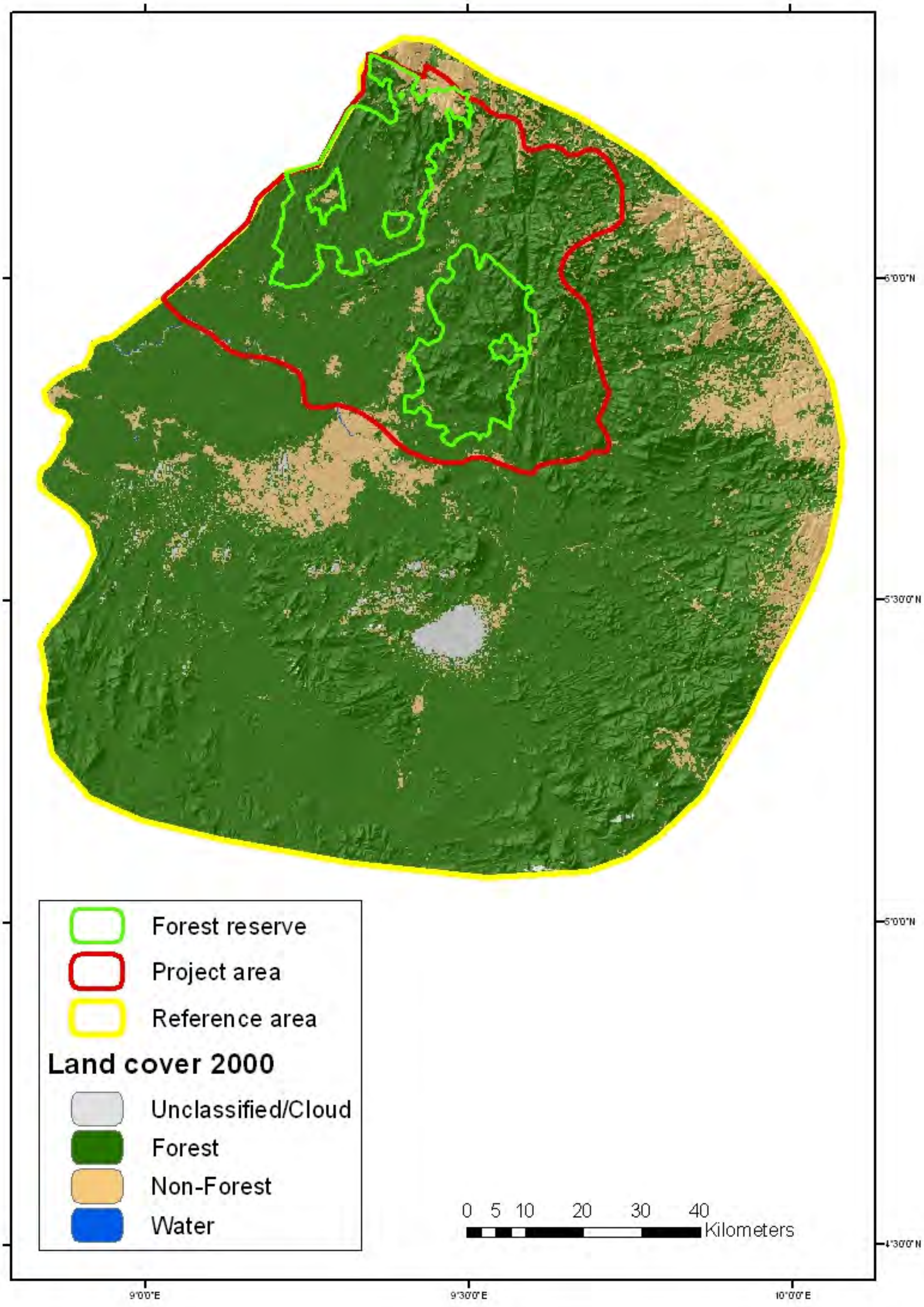
Annex 1.1: Forest cover map 1986



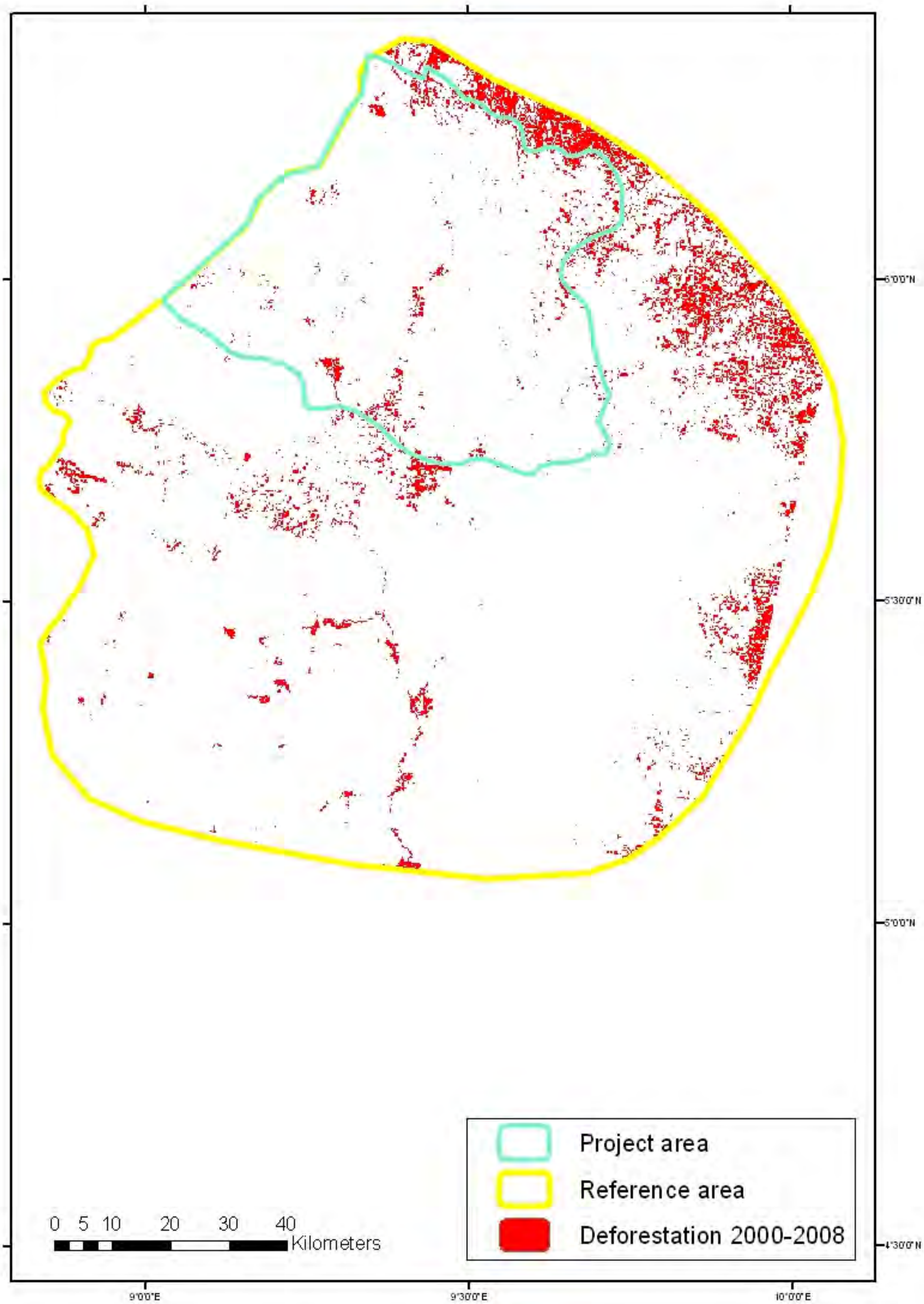
Annex 1.2: Historic deforestation 1986-2000



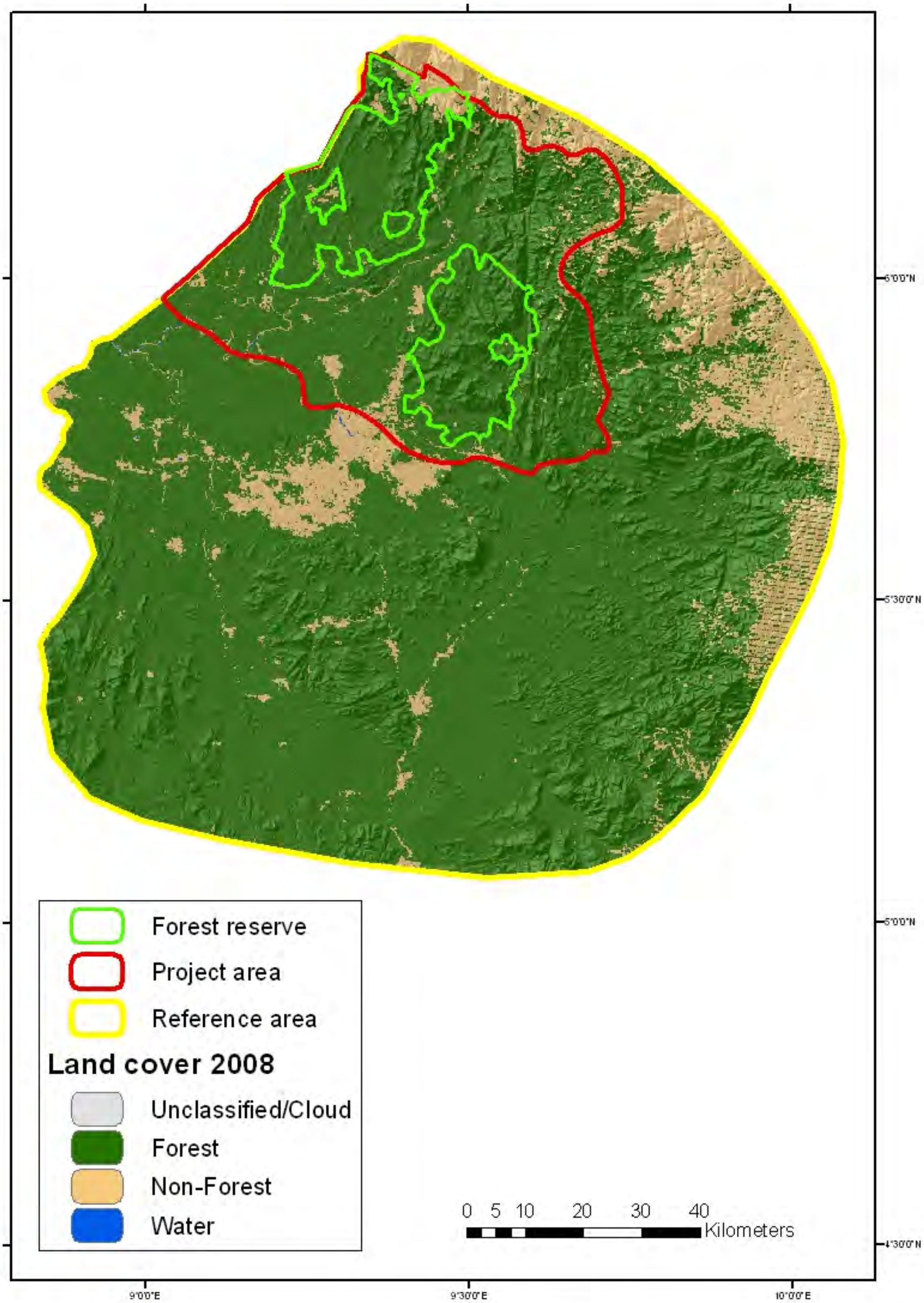
Annex 1.3: Forest cover map 2000



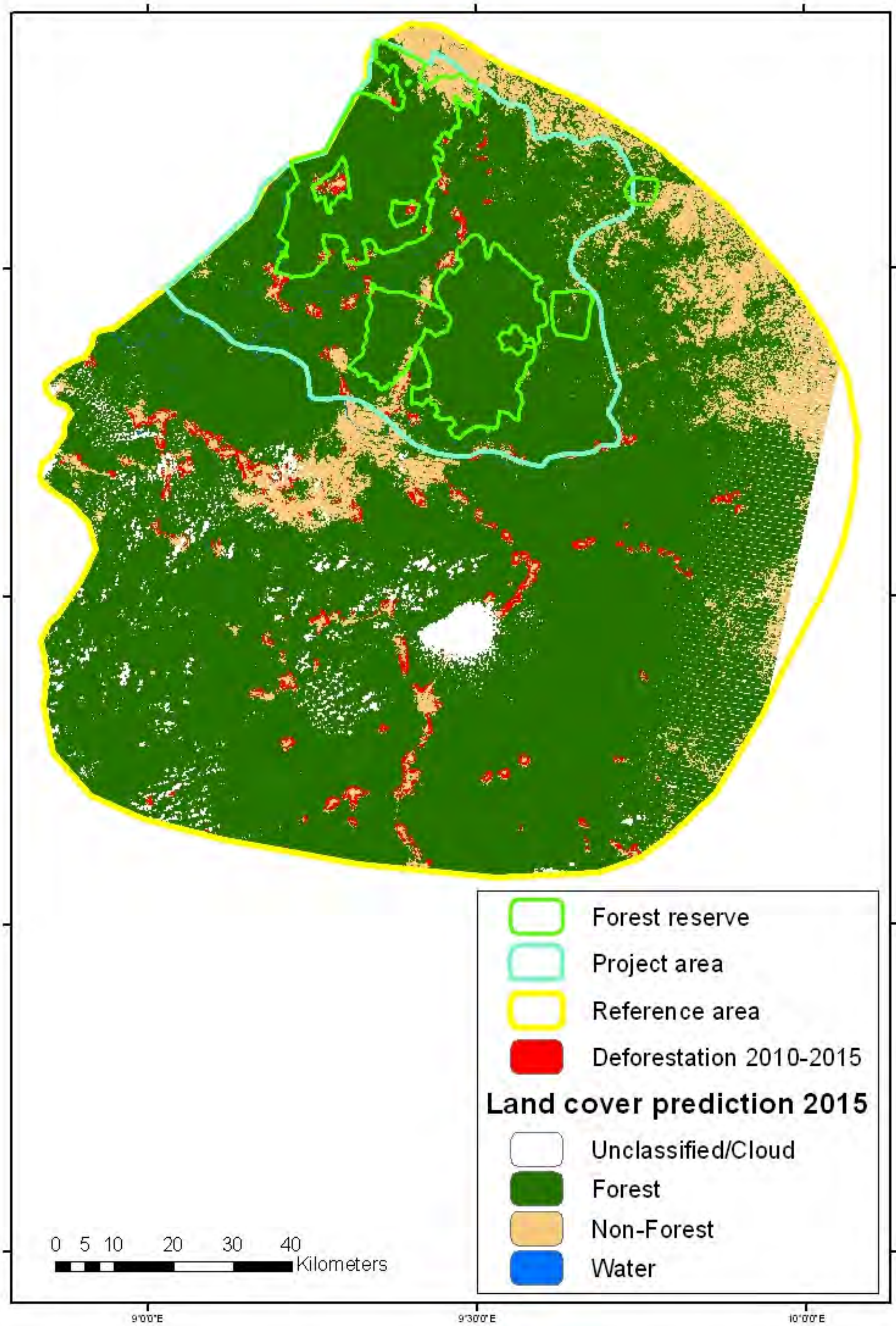
Annex 1.4: Historic deforestation 2000-2008



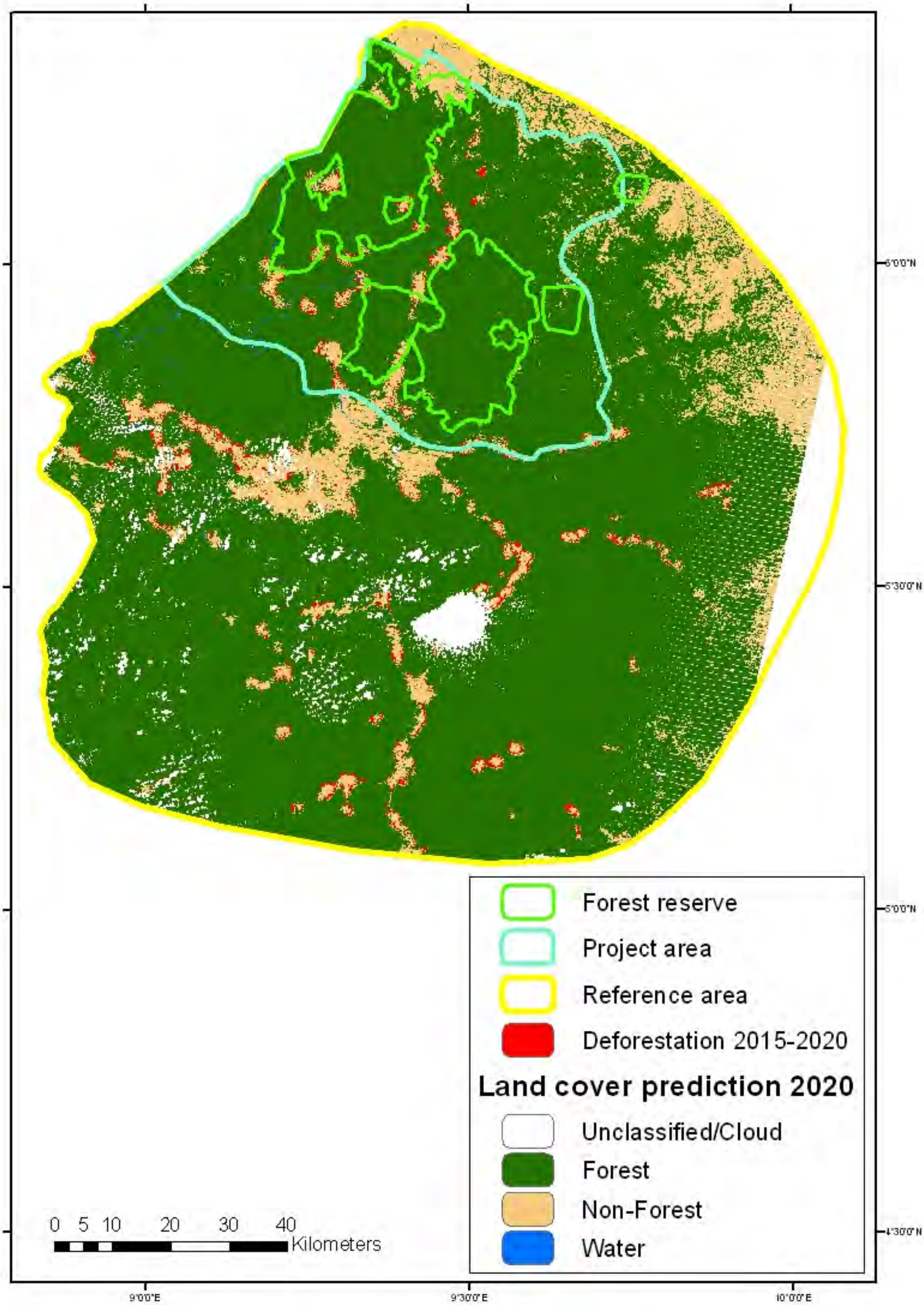
Annex 1.5: Forest cover map 2008



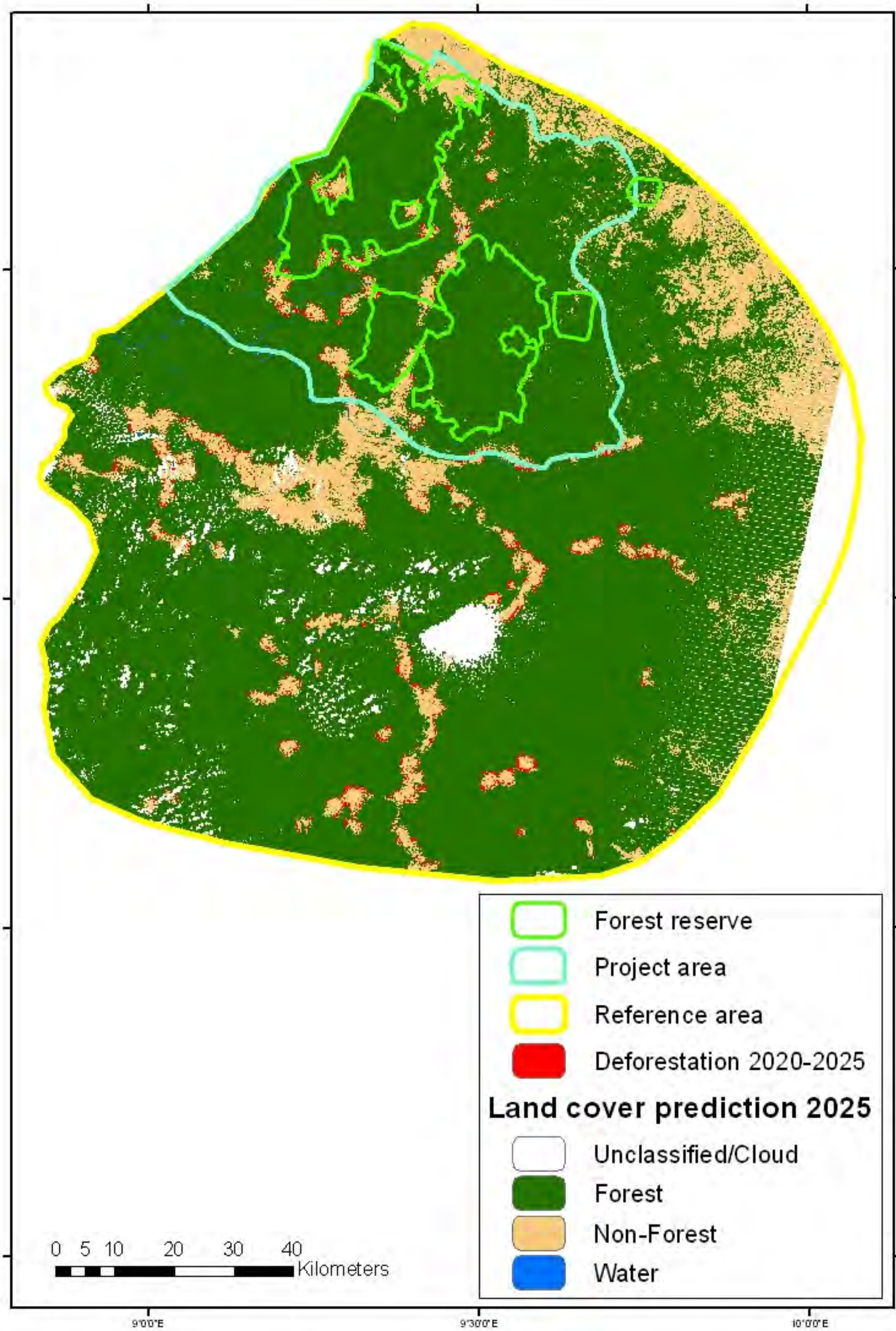
Annex 1.6: Predicted deforestation 2010-2015 and forest cover 2015



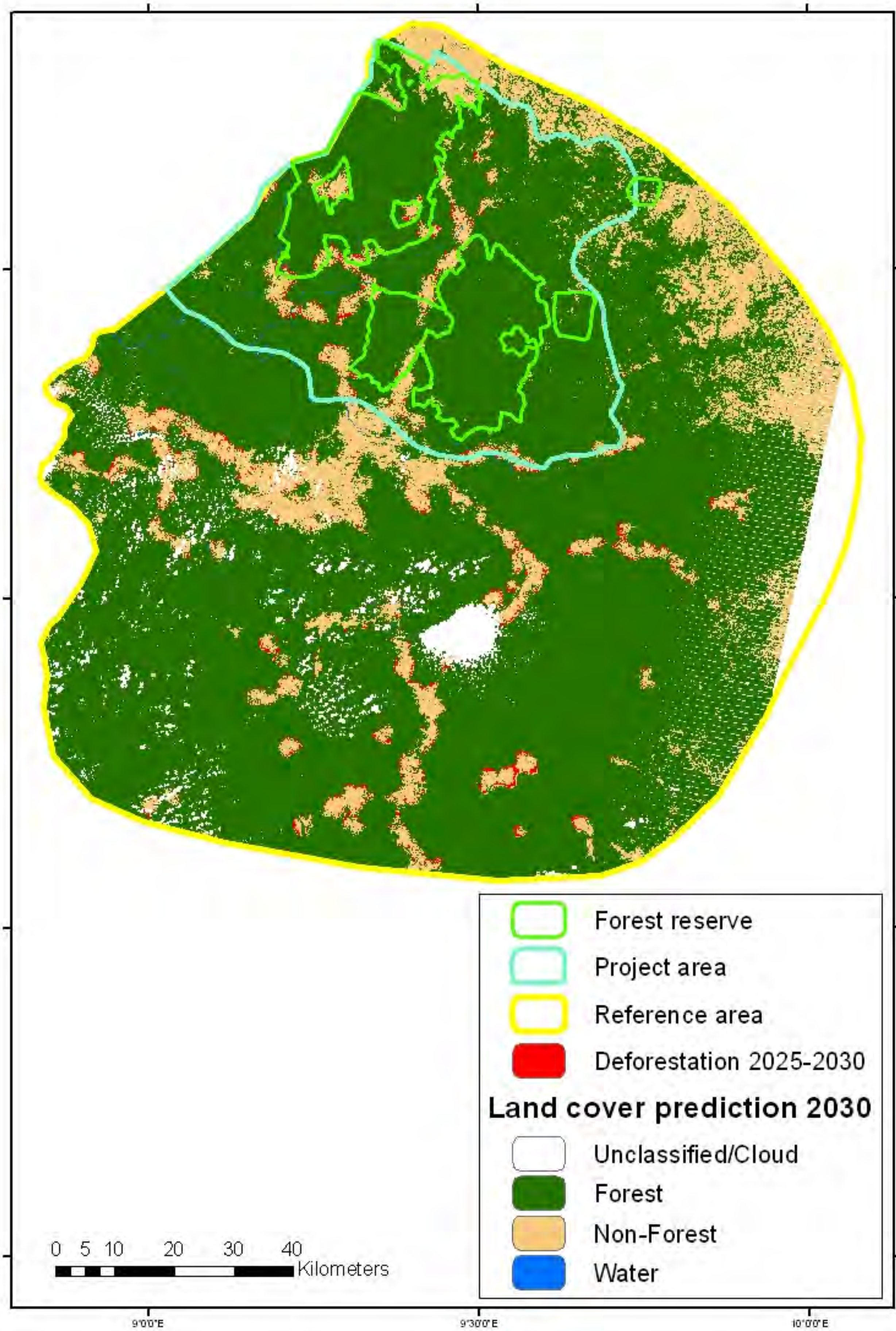
Annex 1.7: Predicted deforestation 2015-2020 and forest cover 2020



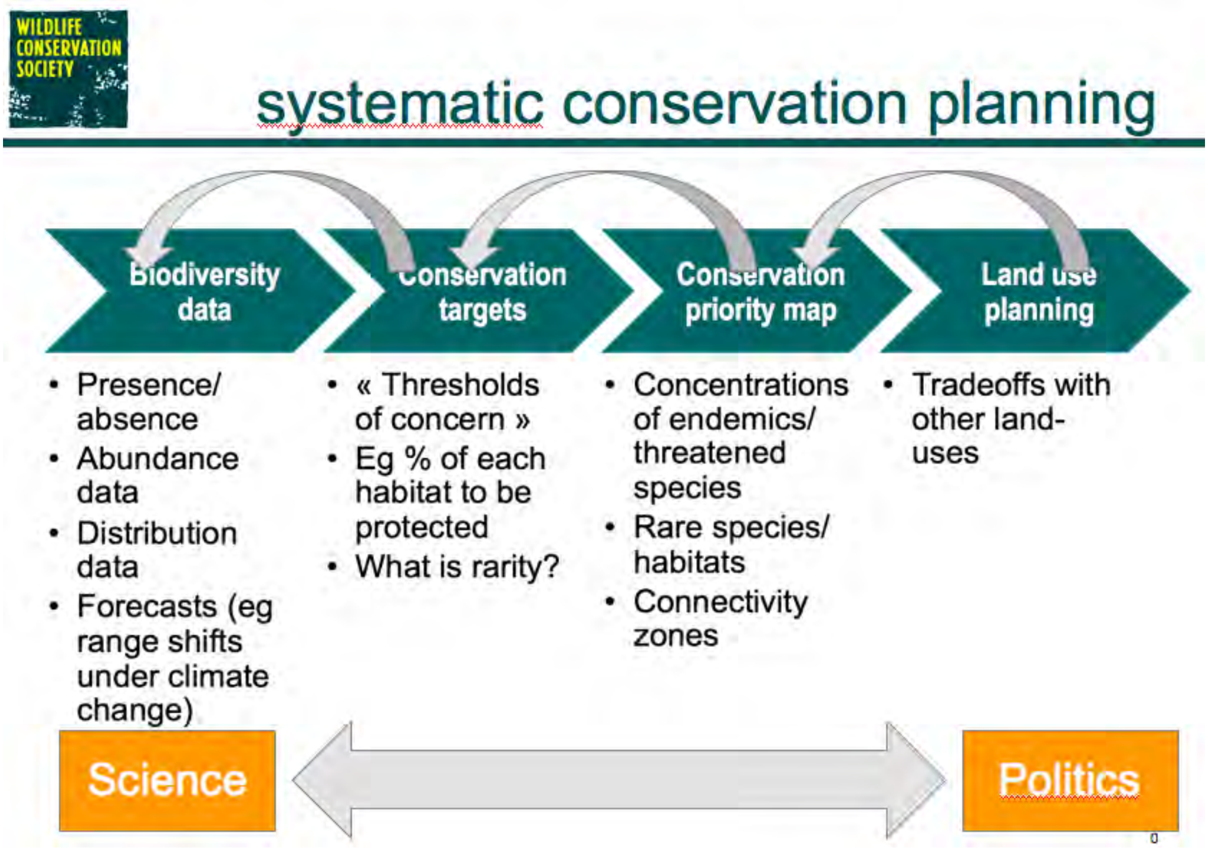
Annex 1.8: Predicted deforestation 2020-2025 and forest cover 2025

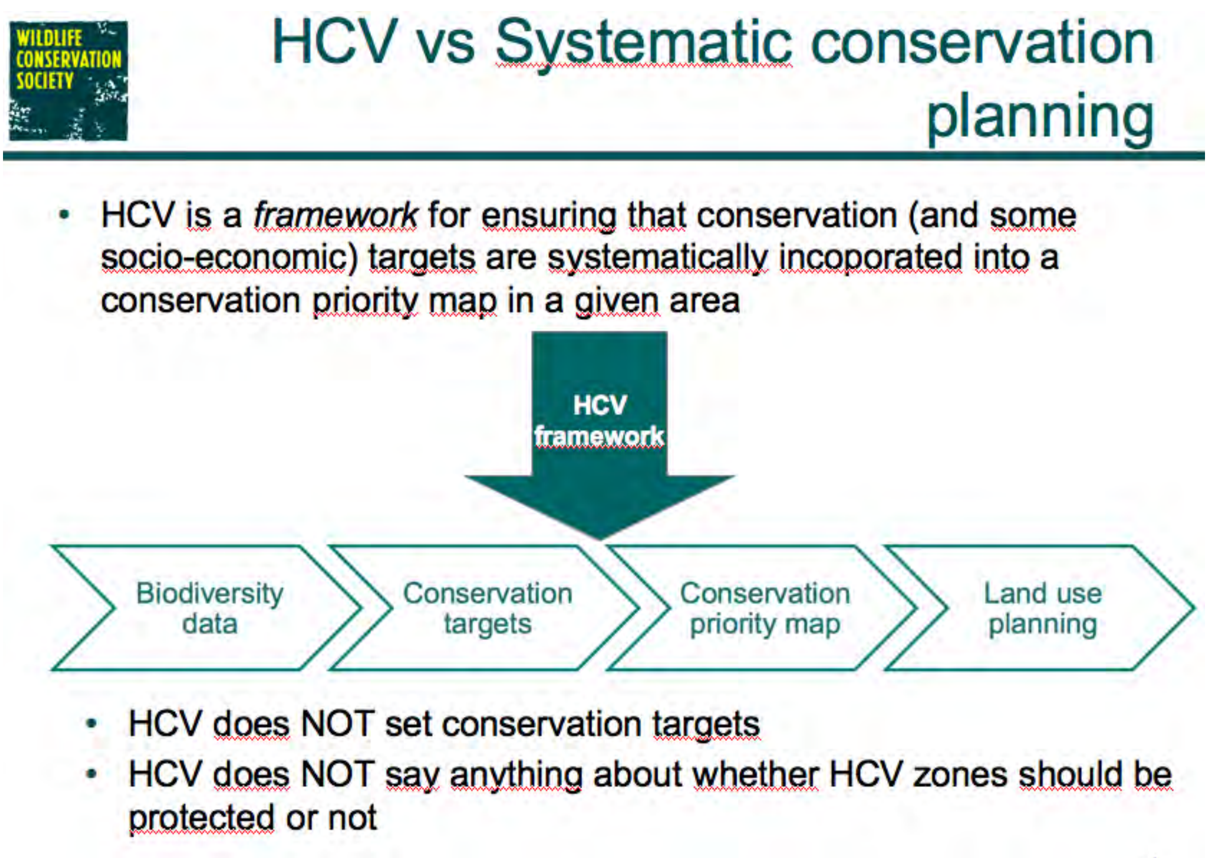


Annex 1.9: Predicted deforestation 2025-2030 and forest cover 2030



Annex 2 : Conservation Planning Process


WILDLIFE CONSERVATION SOCIETY
systematic conservation planning
Biodiversity data
Conservation targets
Conservation priority map
Land use planning
• Presence/ absence
• Abundance data
• Distribution data
• Forecasts (eg range shifts under climate change)
• « Thresholds of concern »
• Eg % of each habitat to be protected
• What is rarity?
• Concentrations of endemics/ threatened species
• Rare species/ habitats
• Connectivity zones
• Tradeoffs with other land-uses
Science
Politics


WILDLIFE CONSERVATION SOCIETY
HCV vs Systematic conservation planning
• HCV is a *framework* for ensuring that conservation (and some socio-economic) targets are systematically incoporated into a conservation priority map in a given area
HCV framework
Biodiversity data
Conservation targets
Conservation priority map
Land use planning
• HCV does NOT set conservation targets
• HCV does NOT say anything about whether HCV zones should be protected or not