UN-REDD
PROGRAMME

MINISTRY OF NATURAL RESOURCES AND TOURISM

Estimating Cost Elements of REDD+ in Tanzania

Prepared by LTS International & UNIQUE forestry and land use for the Ministry of Natural Resources and Tourism (MNRT) and the UN-REDD National Programme in Tanzania

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Acronyms

CBO	Community-based Organization
CCBS	Climate, Community and Biodiversity Standard
CFM	Community Forest Management
DCF	Discounted Cash Flow
EMA	Environmental Management Act
FAO	Food and Agriculture Organization of the United Nations
FBD	Forestry and Beekeeping Division
FCPF	Forest Carbon Partnership Facility
FSC	Forest Stewardship Council
FSU	Forest Support Unit
FTI	Forestry Training Institute
GHG	Greenhouse Gas
FLEGT	Forest Law Enforcement Governance and Trade
ha	hectare
IRA	Institute of Resources Assessment
JFM	Joint Forest Management
JGI	Jane Goodall Institute
LGA	Local Government Authorities
MCDI	Mpingo Conservation and Development Initiative
MNRT	Ministry for Natural Resources and Tourism
MRV	Measurement, Reporting and Verification
NEMC	National Environmental Management Council
NLUPC	National Land Use Planning Commission
NPV	Net Present Value
PFM	Participatory Forest Management

PDD	Project Design Document
PMO-RALG	Prime Minister's Office – Regional Administration and Local Government
REDD	Reduced Emissions from Deforestation and Degradation
R-PP	Readiness Preparation Proposal
SEA	Strategic Environmental Assessment
SFM	Sustainable Forest Management
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forestry Research Institute
TANAPA	Tanzania National Parks
TaTEDO	Tanzania Traditional Energy Development and Environment Organization
tCO2	Tons Carbon Dioxide
TEV	Total Economic Value
TFCG	Tanzania Forest Conservation Group
TFF	Tanzania Forest Fund
TFS	Tanzania Forest Service
TNRF	Tanzania Natural Resource Forum
UNDP	United Nations Development Programme
VCS	Verified Carbon Standard
VPO-DoE	Vice President's Office – Division of Environment
UNFCCC	United Nations Framework Convention on Climate Change
WD	Wildlife Division
WMA	Wildlife Management Area

1. Executive Summary

The study on cost elements of REDD+ in Tanzania is based on data of four REDD+ and Sustainable Forest Management (SFM) projects in Tanzania in addition to an assessment of institutional costs of REDD+ at central government and district level.

Project level data comprised cost-benefit information for the drivers of deforestation and forest degradation in the respective project areas (opportunity costs), data on implementation costs of project activities and data on the costs for getting REDD+ projects certified according to carbon accounting standards (transaction costs).

Opportunity costs, implementation costs, transaction costs and institutional costs were calculated with regard to pilot project areas (in hectares) and targeted emission reductions (in tonnes of carbon dioxide (tCO_2)).

Opportunity costs were calculated based on 1-hectare models of deforestation driving land uses, applying discounted cash flow analysis. The comparative indicator (output of discounted cash flow analysis) for the opportunity costs is the Net Present Value of these land uses.

The results of the study show a heterogeneous picture regarding REDD+ cost elements in the pilot projects. The figure below summarizes the total REDD+ costs per tCO_2. They range between 4.9 and 13.8 US$/$tCO_2$ (see Figure 1).

To obtain a broader picture of opportunity costs at national level, the results of the individual pilot project analyses were nested and processed with the REDD ABACUS software (see Figure 1 showing the output of this exercise). The graph visualizes the costs of emission reductions potentials for three REDD+ pilot projects and it becomes obvious that land use changes and related opportunity costs vary over the project regions. For example, opportunity costs of avoiding land use change from forest to shifting cultivation are twice as high in the Jane Goodall Institute project as in the Tanzania Forest Conservation Group (TFCG) in Mjumita/Lindi.

The main product of the cost elements study is a comprehensive Excel-based calculation tool, which enables project managers to estimate all four cost elements of REDD+ within their project context. This report introduces the tool and explains its functions and possibilities.

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Figure 1: REDD+ costs per tCO_2

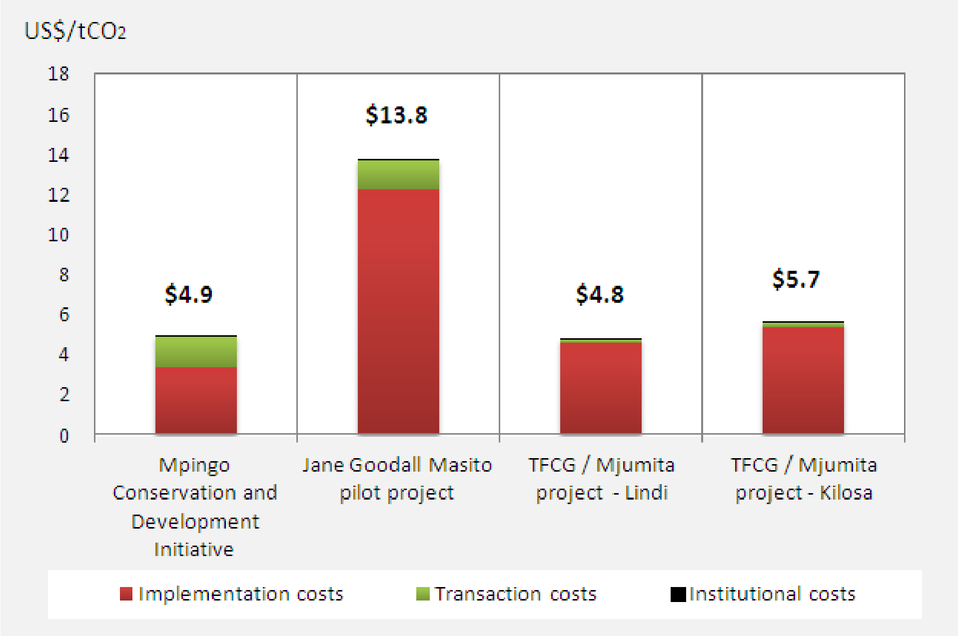
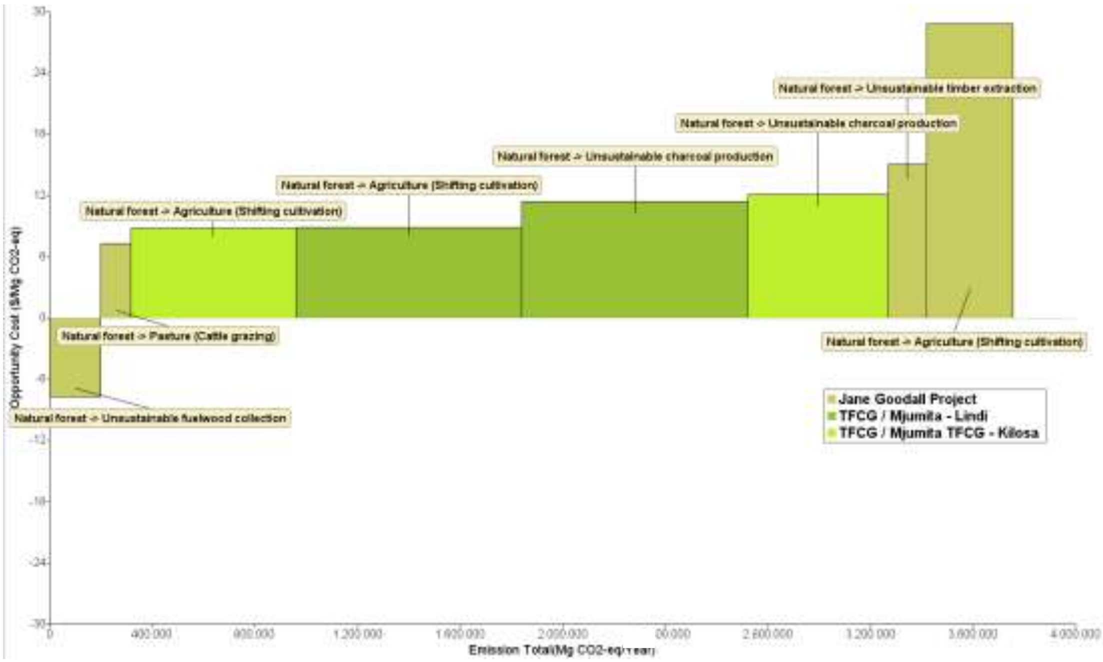


Figure 2: Opportunity cost curve for three pilot projects



In general, data availability for opportunity costs varied significantly between the pilot projects. Not all of the pilot projects have established a land use change matrix, which is the essential input information to elaborate REDD+ cost curves, thus estimates were drawn with the respective project staff. Transaction costs were only considered by certain projects and most have budgeted for implementation costs only over the initial three to five years of the project lifetime. Institutional costs were assessed at central government and district level based on studies and interviews.

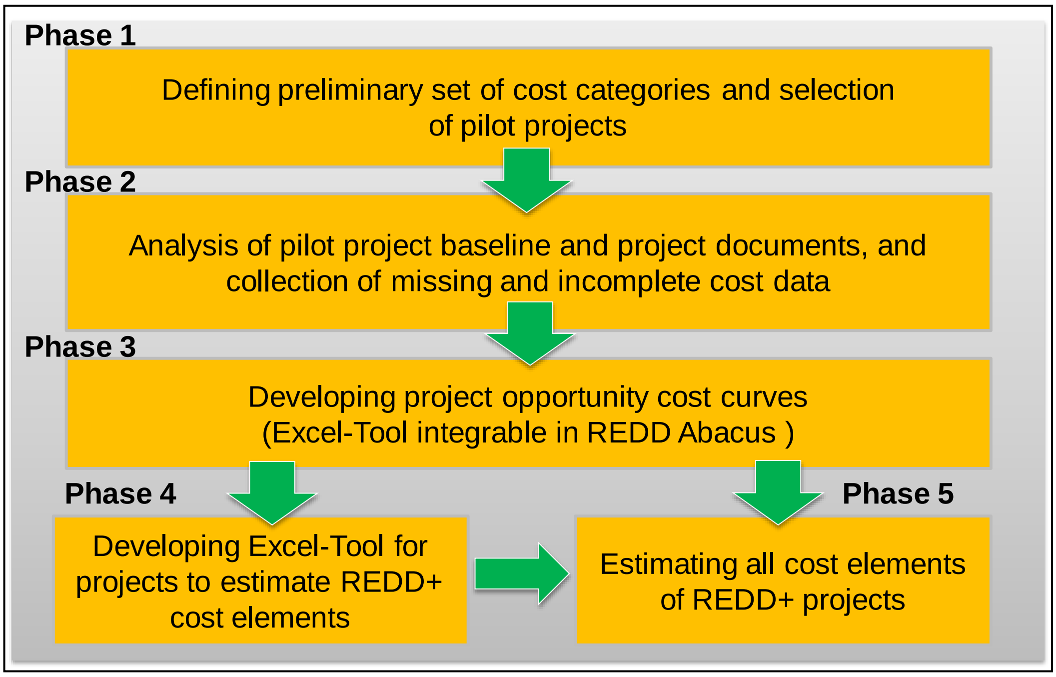
Due to these restrictions of data availability, assumptions and default values were used to complement missing information and elaborate comparable results. These assumptions are explained in detail in the respective chapters of the report. Thus, all results presented in this report should be considered as preliminary and dynamic, considering improving data availability in the near future – e.g. by completion of the National Forestry Resources Monitoring and Assessment (NAFORMA).

2. Objective of Study

The presented study aimed to identify and estimate cost elements of REDD+ in Tanzania as well as elaborate REDD+ opportunity cost curves at project and at national level. The focus was on the nine REDD+ pilot projects in Tanzania, which have been established across the country over the past few years through funding from the Royal Norwegian Embassy. The study consisted of six main tasks:

1. Define the REDD+ cost elements in Tanzania;
2. Analyze the cost elements (i.e. opportunity costs, implementation costs, transaction costs and institutional costs) for selected REDD+ pilot projects;
3. Analyze available pilot project data and derive REDD+ costs curves at project level;
4. Ensure stakeholder participation during all phases of the study;
5. Develop an analyses tool to estimate REDD+ costs; and
6. Use the REDD ABACUS software to generate REDD+ cost curves.

Figure 3: Overall study approach



The overall approach of the study considered a high level of stakeholder participation and targeted focus on the beneficiaries of the outcomes, namely the REDD+ pilot projects and the Ministry for Natural Resources and Tourism (MNRT). Stakeholder involvement has been considered by conducting three stakeholder workshops during the decisive phases of the study (inception phase, feedback on preliminary results, completion and dissemination).

A workplan was developed in accordance with the Terms of Reference and the Inception Report. The respective deliverables and milestones accomplished are listed in Table 1: Project deliverables.

Table 1: Project deliverables

Deliverables and milestones	Timeline
First national stakeholder workshop and pilot project selection, Dar es Salaam	05.10.2011
Consultations and pilot project data collection phase in Tanzania	03.10.-14.10.2011
Data analysis and elaboration of beta version of Excel tool to estimate project level REDD+ costs	15.10.2011-12.02.2012
Feedback workshop for pilot projects on Excel tool and preliminary results, Dar es Salaam	13.02.-15.02.2012
Final data analysis and work on Excel tool	16.02.-11.03.2012
Training workshop for pilot projects on Excel tool, Dar es Salaam	12.03.2012
Second national workshop, Dar es Salaam	13.03.2012
Final version Excel tool and REDD Abacus produced national cost curves	14.03.-20.04.2012
Final report	20.04.2012
Policy brief	20.04.2012
Scientific paper submitted to "Carbon Balance and Management" journal	May 2012

3. Existing Concepts

The Tanzania REDD+ cost study in the light of existing concepts

In the process of developing the national REDD+ framework, **investors, donors and policy-makers have been highly interested in cost information** in order to develop strategies, allocate budgets, and to assess the effectiveness of reducing emissions from avoiding deforestation and forest degradation. Several global REDD+ cost elements studies were conducted in the past (Eliasch Review, 2008; Boucher, 2008; Grieg-Gran, 2008; Kindermann et al, 2008) predicting that payments for maintaining forest carbon stocks have a great potential to be a cost-effective climate change mitigation and human development measure.

In general there are **three different approaches to estimate cost elements of REDD+:** i) local-empirical models; ii) global-empirical approaches; and iii) global simulation models.

Local-empirical Models

The local-empirical estimates are **based on local survey and information, estimating per-area cost estimates ($/ha) and carbon density (tCO_2/ha) of a respective REDD+ activity location**. Boucher's (2008) review of 29 empirical studies estimated opportunity costs of REDD+ at a range of US$ 0.84 – 4.18/tCO_2 with a mean of US$ 2.51/tCO_2 and 28 out 29 studies at less than US$ 10 /tCO_2 and mean cost for Africa of US$ 2.22/tCO_2. However, only opportunity costs are quantified; these do not sufficiently take into account other cost elements associated with implementation, monitoring, reporting and verification and institutional set-up of REDD+ framework.

Global-empirical Models

Global-empirical models **use local empirical data and combine these to global per-area costs of deforestation and use uniform estimates on the carbon density (tCO_2/ha)**, which results in a global estimate of opportunity costs (US$/$tCO_2$) (Boucher, 2008). This method was used for the Stern Review (2006), undertaken by Grieg-Gran (2008), using a mean carbon density of 390 tCO_2/ha resulted in a global REDD+ costs of US$ 2.76 – 8.28/tCO_2 with a midpoint of US$ 5.52/tCO_2) considering opportunity costs and administration costs of REDD. This approach ignored the significant variations of carbon densities from region to region and led to highly aggregated estimates with a large level of uncertainty.

Global Simulation Models

The global simulation models such as GTM, DIMA and GCOMAP (Kindermann et al, 2008), **estimate REDD+ costs by simulating the development of the world economy taking into account the forestry, agricultural, fossil fuel using energy sectors**. As a result the simulations provide supply curves of REDD+ (price vs. quantity for emissions reductions in tCO_2). However, these models also mainly focus on the estimation of opportunity costs, and do not take into account other cost elements of REDD+. Kindermann et al (2008) estimated that a 50 % reduction of deforestation by 2030 globally would cost in the range of US$ 9.27 – 20.57/tCO_2 while African forestry related emissions reduction would range between US$ 5.20 - 12.3 /tCO_2.

Additional REDD+ Costs

Apart from opportunity costs, there are additional costs to be considered in REDD+ such as **implementation costs, transaction costs and institutional costs**. However, data on robust estimates hardly exists (Boucher, 2008). Grieg-Gran (2008) estimates that implementation and transaction costs in the range of 15-20 % of the total REDD+ cost in the largest tropical forest countries such as Brazil, Indonesia, and Democratic Republic of Congo among others. Nepstad et al (2007) estimated implementation costs in the Amazon region at about US$ 0.58/tCO_2 based on experience from existing Payments for Ecosystem Services (PES) schemes. Anitonori and Sathaye (2007) estimated transaction costs based on 11 forest carbon projects that averaged US$ 0.38 /tCO2 (in a range of US$ 0.03 – 1.23/tCO_2). Grieg-Gran (2008) estimated administration costs in 8 tropical forest countries of existing PES schemes to average US$ 0.04/tCO_2 and in total (implementation, transaction and administrative costs) US$ 1/tCO_2.

However, most of these studies were conducted prior to 2008 at a time where practical REDD+ pilot projects had hardly developed and national REDD+ frameworks were at a very early stage of development, thus the estimates are all based on project and schemes not directly related to REDD+. In addition, **top-down REDD+ cost curves do not sufficiently reflect the full spectrum of REDD+ costs, thus underestimating the real costs of REDD+ and misleading decision-makers and policy-makers** (Boucher, 2008) because transaction and implementation and institutional costs are omitted from the estimates. Moreover, top-down opportunity cost estimates often do not consider economic activities that are not integrated into formal markets such as subsistence farming and ignore variations among regions in countries. Therefore, **participatory bottom-up approaches are considered more appropriate to estimate the real costs of REDD+ and to take into account regional variations and economic conditions.**

As a robust bottom-up approach to estimate REDD+ opportunity and implementation costs, Fisher et al (2011), conducted a study in Tanzania by taking into consideration the regional variations and economic conditions. The estimates were conducted for the two major Tanzania drivers of deforestation including agricultural expansion and charcoal production by using regional district-scale carbon losses from deforestation and land use rents. Therefore the opportunity costs for the 53 districts for avoiding charcoal and agricultural expansion varied significantly ranging between US$ 1.90 – 13.40/tCO_2 (median US$ 3.90/tCO_2) indicating the high variability of opportunity costs on national scale and showing the importance to use bottom-up approaches to robustly estimate REDD+ costs on national scale.

The implementation costs for avoiding GHG emissions through investments in doubling agricultural production and more efficient charcoal exceed the opportunity costs and ranged between US$ 1.63 – 17.05/tCO_2 (median US$ 6.52/tCO_2); these also included monitoring costs of about US$ 2.95/ha/yr. The study concludes that opportunity and implementation costs of avoiding GHG emission from REDD+ are likely to cost more than global top-down models suggested by Fisher et al (2011).

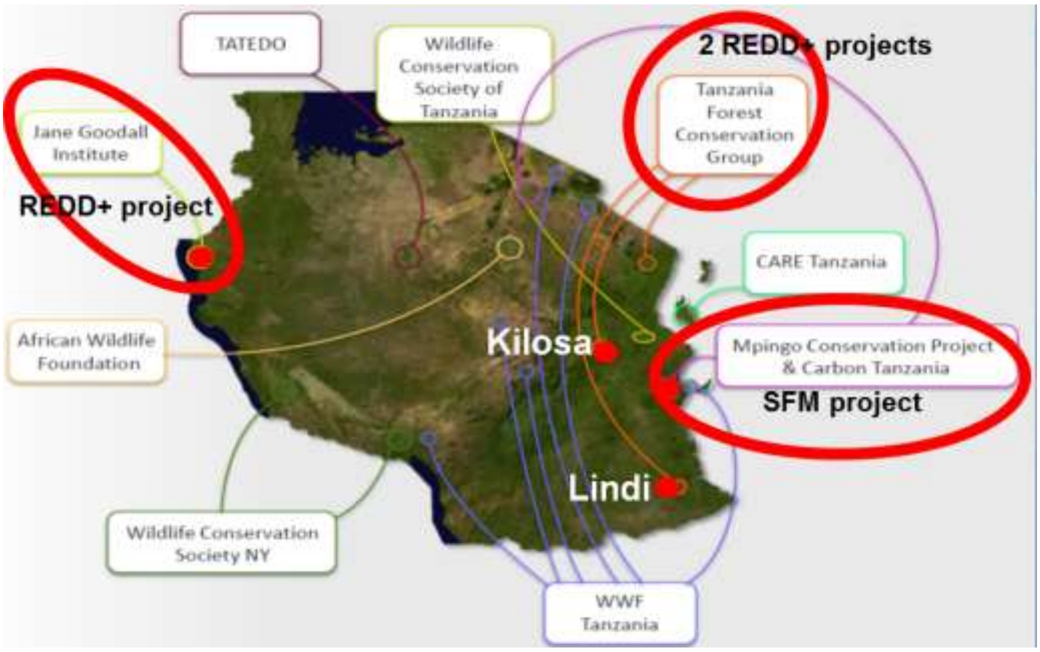
As part of the national REDD+ strategy, nine REDD+ pilot projects have been initiated with the objective to inform the development of the national REDD+ framework and over the past years practical experiences have been made to undertake REDD+ activities with the availability of robust cost data on REDD+ pilot activities. Building upon the work done by Fisher et al (2011) and data collected from three Tanzanian REDD+ pilot projects, the study seeks to estimate the full spectrum of REDD+ costs based on a bottom-up approach using existing cost data, which makes a comparison with existing REDD+ cost studies possible. In addition, this study serves as a practical methodological framework example to consistently assess REDD+ cost elements that takes into account regional forest carbon, land use economics and land use change pattern variations providing decision-makers a robust economic decision making basis to strategize and prioritize REDD+ activities and investments in their countries.

4. Methodology

How to estimate cost elements of REDD+

The major source of data and information for the elaboration of REDD+ cost elements and related cost curves were the nine REDD+ pilot projects supported by the Royal Norwegian Embassy in Tanzania (see map below). The projects are being implemented in various ecosystems, under various land tenure types and apply a wide variety of REDD+ strategies. An important source of information for the assessment of REDD+ costs elements was the socio-economic baseline studies of these pilot projects and the project documents within the project designs and related project budget breakdown. Further, close cooperation and exchange of information and experience with the implementing NGOs of these pilot projects was sought for the identification of a comprehensive set of cost elements and for the verification of expert assumptions.

Figure 4: Map of the nine REDD+ pilot projects in Tanzania



Source: Tanzania REDD Initiative 2011

4.1 Pilot project selection

Considering that the nine REDD+ pilot projects in Tanzania reflect highly heterogeneous project conditions and project designs, and that data availability in the projects was a decisive factor for the accomplishment of the study, four of the most advanced REDD+ pilot projects were selected for in-depth analysis. The pilot projects have been preselected during the first national stakeholder workshop (05.10.2011 in Dar es Salaam) and a final decision was taken based on data availability and geographic distribution. The projects are characterised in the table below.

Additionally, the Angai Forest Reserve was analyzed to obtain information on opportunity costs in this historical PFM area. However, its rather unique history of decades of support from a range of different donors and projects, coupled with the corresponding poor progress made in progressing with formalisation of community based forest management mean that data relating to implementation costs is fragmented and atypically high. Following extensive discussion of the preliminary results at the final workshop held in Dar es Salaam on 13.03.2012, it was decided to remove this site from the analysis to avoid distorting overall findings.

Table 2: Pilot project selection

Pilot project (Acronym)	Project characteristics
Jane Goodall Institute REDD Program (JGI)	Project location: Kigoma Affected forest type: Guinea-Congolean Data availability: all baselines available Drivers of deforestation: Agriculture, logging, charcoal/fuelwood, pasture Project design: Conservation, alternative income generation
Tanzania Forest Conservation Group (TFCG)/Mjumita	Two project locations: Kilosa and Lindi Affected forest types: Coastal forest and Eastern Arc Data availability: all baselines available Drivers of deforestation: Agriculture, charcoal/fuelwood Project design: Conservation, alternative income generation
Mpingo Conservation and Development Initiative (MCDI)	Project location: Kilwa Affected forest type: Costal forest Data availability: all baselines available Drivers of deforestation: fire; no direct economic drivers Project design: PFM based sustainable logging

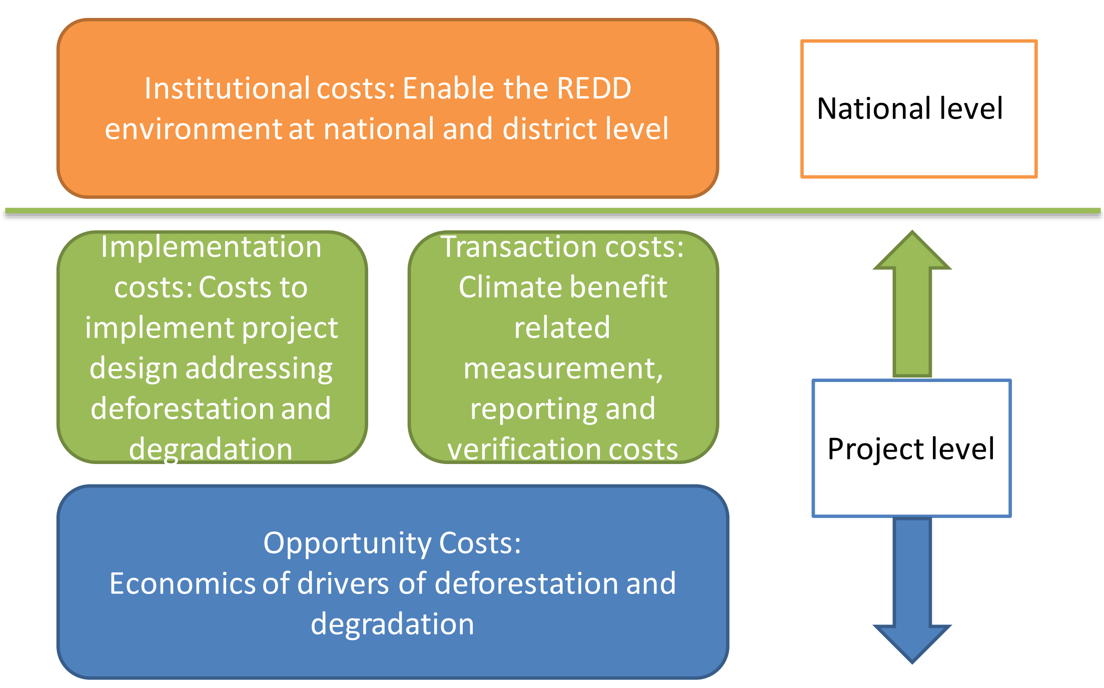
4.2 Cost elements of REDD+

Establishing and implementing REDD+ activities generates costs. These costs can be grouped into four general categories (see Figure 5):

1. opportunity costs resulting from the forgone benefits that deforestation would have generated;
2. implementation costs of efforts needed to reduce deforestation and forest degradation;
3. transaction costs of establishing and operating a REDD+ project; and
4. institutional costs to enable the REDD+ environment and set the technical and institutional stage at national level.

In the subsequent chapters, each of the four cost elements of REDD+ is explained in more detail, thereby putting emphasis on the conditions and realities found in the Tanzanian REDD+ pilot projects` context.

Figure 5: Cost elements of REDD+



4.3 Opportunity costs

With regard to opportunity costs the authors refer to the excellent World Bank publication "Estimating the Opportunity Costs of REDD+: A training manual" (2011). The World Bank conducted a stakeholder workshop to introduce the concept of opportunity costs in Dar es Salaam in 2010.

The World Bank publication explains in details the theory and methodology of opportunity cost estimation, including implementation and transaction costs, in the context of REDD+. Thus, for this report we focus on the definition of opportunity costs and the economic assumptions behind it.

Our analytical framework is consistent with the World Bank's definition and understanding of opportunity costs; basic terms and assumptions are adopted. Where this study deviates from these assumptions and definitions it is clearly stated – e.g. in the present study opportunity cost analysis was undertaken from the perspective of the land user.

It is important to note that opportunity cost analysis is based on land use changes. Therefore, in addition to the land use legend, information on current land uses and land use changes and the related carbon stocks at the project level are required. The necessary input information is explained in more detail in the chapter on using the Excel-tool (Annex I).

Opportunity cost analysis is an economic approach to monetize profits from these land uses, based on the calculation of the Net Present Value (see box on NPV calculation). The NPV is the result of a Discounted Cash Flow analysis (DCF) of the costs and benefits for a certain land use over a defined period of time. Comparing the NPV ($ / ha) of various land uses indicate the most profitable land use (e.g. profits from forest, agriculture, pasture). The difference between the higher NPV and the lower NPV is the opportunity cost, indicating the foregone monetized value the land user has to incur when opting for the land use with the lower NPV.

Box 1: The Net Present Value (NPV)

Net present value (NPV), or sometimes called present value, is used to estimate the profitability of a land use over many years. NPV takes into account the time-value of money. Since waiting for profits is less desirable than obtaining profits now, the "value" of future profits is discounted by a specific percentage rate, often ranging from 2- 20%.

With multi-year analysis, NPV is a discounted stream of profits (revenues minus costs of capital, land and labour inputs).

$$NPV = \sum_{1=t}^{T} \frac{\Pi_t}{(1+r)^t}$$

Where t = year, T = length of time horizon, Π = annual profits of the LU ($/ha), r = discount rate. The major assumptions introduced at the stage of NPV calculation are the discount rate (r) and the time horizon (T).

For discount rates, NPV analyses typically use loan interest rates, which are set by a national bank or the government. Such rates can range from 10-30%. Although agricultural loans are rarely available, especially in remote areas, bank interest rates do serve as a good indicator of the time value of money. The interest rate reflects the opportunity cost of obtaining profits - not now - but in the future.

High discount rates can dramatically reduce the viability and attractiveness of long-term investments. These include enterprises such as forestry, agroforestry, and cattle systems where initial years require up-front investments and payoffs occur 5-20 years later. Costs are scarcely discounted, whereas the value of future earnings can be significantly lower.

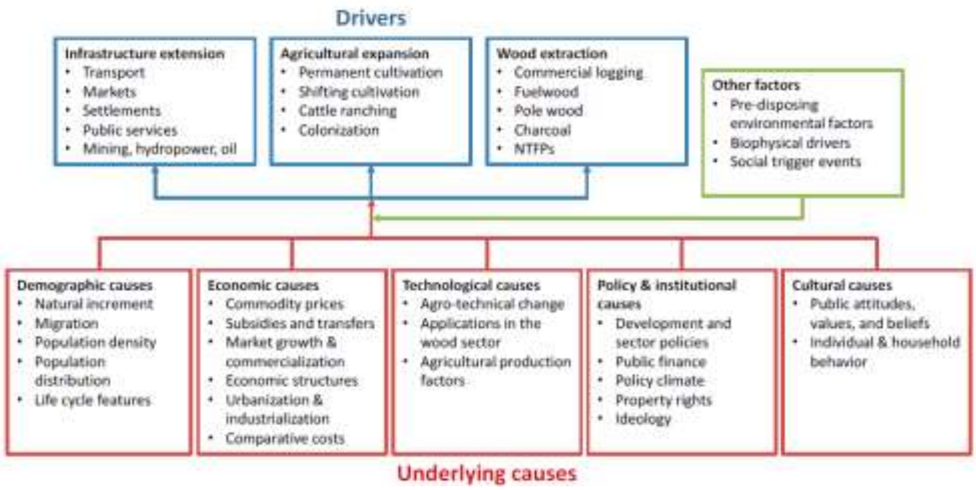
Source: World Bank (2011)

4.3.1 Economics of drivers of deforestation and degradation

Land use changes are caused by drivers that may originate from various sources and intentions. Each REDD+ project requires a coherent analysis of these drivers, in order to define project interventions that can effectively lower emission rates and achieve permanent success. Moreover, the analysis of drivers contributes to all essential aspects of project feasibility and designing project interventions. It is also necessary for the definition of the reference areas and leakage belt as well as for baseline modelling and monitoring baseline assumptions. Figure 6 shows the great variety of direct and indirect drivers of deforestation and forest degradation. Major direct drivers include infrastructure expansion, agriculture and wood extraction for various end uses (timber, fuelwood, charcoal, etc.). Behind these drivers that can be measured in terms of area deforested or degraded are a set of interlinked motivations of the driving agents that are explained in respective publications. Again, these agents are driven by demographic, economic, technological, political or cultural intentions.

Opportunity costs analysis, theoretically, could give a monetary value to any of these drivers and underlying causes. Precondition to do so is that these drivers are adequately assessed and quantified. For the purpose of the present study, focus was put on economically motivated direct drivers. For these drivers, data and information was available at project level. Nonetheless, other drivers could be easily included in the developed calculation tool at a point when quantified information for the projects will be available.

Figure 6: Drivers of deforestation and degradation



Source: Forest Trends (2011)

Each driver or a combination of drivers is responsible for paths of land use change patterns in the past and in the future. Forest areas converted to other land uses may be attributed to these drivers. These spatial patterns of land use change are typically documented in a land use change matrix. Knowing these land use change patterns, the related spatial information and the underlying drivers of the land use change, this information can be correlated to the carbon stock information and the NPV for the respective land uses. With this input information opportunity cost estimation can be processed for projects, jurisdictions or at national level. How to use the land use change matrix and related opportunity cost estimation is explained using REDD+ pilot projects as examples in Annexes 3-5 of this report.

4.3.2 Linking opportunity costs with carbon stock changes

Each land use is characterized by a "typical" carbon stock (tCO_2/ha). Since each land use type is also characterized by a typical NPV ($/ha), both parameters can be linked, resulting in opportunity cost per ha.

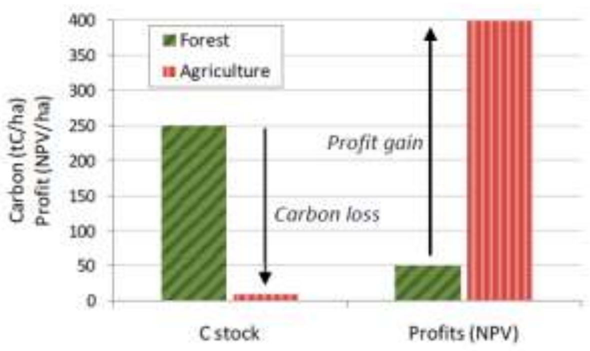
Figure 7 illustrates a simple example of this correlation:

- The carbon stock of natural forest is 250 tC/ha which equals 917 tCO2/ha.
- The carbon stock of agricultural use is about 10 tC/ha or 37tCO2/ha.
- The NPV of forest is 50 $/ha, the NPV for agriculture is 400 $/ha.

Conserving the forest at its current state instead of converting it to agriculture would result in opportunity costs of 350 $/ha (difference between 400$/ha and 50$/ha), while the carbon conserved amounts to 880 tCO_2/ha (difference between 917 tCO_2/ha and 37 tCO_2/ha). Hence, the opportunity cost per tCO_2 due to forest conservation amounts to 0.40 $/$tCO_2$.

Based on this calculation cost curves can be developed at project and national level. Since this is explained best with a real example, the reader is referred to chapter 6.4 for more information.

Figure 7: Correlation of NPV and carbon stock



Source: World Bank (2011)

Box 2: The "true" value of forest in Tanzania

Knowing that the estimation of opportunity costs only partly reveal the macro-economic value of forests in Tanzania, the authors would like to emphasise that to date non-monetized forest values, such as biodiversity, water supply and soil conservation constitute significant benefits to the economy and the society.

The Resource Economic Analysis of Catchment Forest Reserves in Tanzania in the year 2003 has investigated the full set of possible forest benefits and monetized their values. The results show a significant higher value of natural forests than the results of the opportunity costs analysis in this study. The average actual total economic value (TEV) established added up to a total of 17,250 US$/ha.

A direct comparison of this value against the values estimated within the present opportunity costs exercise is not possible because different assessment approaches are used. Calculation of the TEV was based on an infinite cash flow analysis, while the NPV calculation considered maximum project duration of 30 years. The TEV implied non-monetary revenue streams (e.g. for biodiversity and water) by applying surrogate values, while the opportunity costs` NPV only considered marketable products within the respective pilot project context. In both cases a discount rate of 10% was applied. Nonetheless, the TEV illustrates the economic potential natural forests in Tanzania host, although this potential has not been recognized economically and acknowledged so far.

The developed Excel tool provides the possibility to consider and monetize co-benefits. However, in the selected pilot project case studies no quantification of these benefits has been conducted so far. Thus, no input information could be processed and factored in the NPV calculation of forest opportunity costs.

4.4 Implementation costs

The implementation costs of REDD+ at project level are closely related to the respective project design. The project design should explicitly address the identified drivers of deforestation (see also section 4.3 on opportunity costs), leakage and project management. Thus, implementing activities typically are:

- Setting up project infrastructure
- Establishing PFM structures
- Demarcating project area
- Patrolling forest

- Planting and tending of trees
- Training of sustainable forest management practices
- Intensifying agriculture and livestock management outside the project area
- Improving energy supply and energy efficiency
- All types of alternative income generating activities.

For the purpose of this study all costs that enable the project to pursue the project's design targets and are incurred by the project (directly or indirectly through REDD+ project funding) have been considered as implementation costs. This includes, for example, office costs and personnel. In parts these overhead costs also constitute part of the transaction costs since they enable the project to certify and market their carbon benefits. In the long run establishing and maintaining implementation activities will be the major costs.

For the present study implementation costs were derived from the pilot project budgets and implementation plans. Since the project funding periods are limited (3 to 5 years), no information on implementation costs over the full duration of the project life was available. Thus, implementation costs have been extrapolated together with pilot project team members based on cost estimates from the current project phase. These assumptions considered:

- Initial costs in the starting phase of the project
  - Setting up project infrastructure
  - Conducting basic assessments and studies
  - PFM establishment (if not a regular activity over the full project duration)
  - Initial trainings and capacity building
  - Other initial costs
- Periodically returning costs
  - Regular trainings for communities (e.g. fire management, SFM training, agricultural trainings)
  - Other periodical costs according to project designs
- Annually returning costs
  - Staff costs, costs for permanent project offices, communication and transport
  - Patrolling
  - Any kind of permanent foreseen project activities according to the project design

In typical REDD+ project designs at least a portion of the expected revenues from carbon finance schemes are allocated to cover implementation costs over time. Since the use of returns through carbon finance schemes for future implementation in the pilot projects has only partly been quantified, this possibility was not factored in. Thus, the projected implementation costs are gross implementation costs. The projected implementation costs in the pilot projects could be significantly reduced through re-investments of carbon revenues into the project.

Results of this study can be compared to the results of Fisher et al (2011). The authors have established implementation costs in Tanzania, addressing the main deforestation drivers – agriculture and charcoal – at medians of US$ 6.50 versus US$ 3.90 per tCO_2. Therefore, it is important to note that the present study aimed at using readily available project data to establish an estimation tool, rather than calculating the implementation costs necessary to effectively address the drivers of deforestation.

4.5 Transaction costs

Transaction costs are incurred throughout the process and relate to climate performance and benefit measurement costs related to REDD+ activities. Transactions costs are typically considered separate from implementation costs, since by themselves they do not reduce deforestation or forest degradation. Typical transaction costs are: i) REDD+ project development, including baseline survey and Project Design Document preparation costs; ii) negotiating contracts with buyers; and iii) measurement, reporting, and verification of carbon stock changes. Transactions costs are incurred by the REDD+ project and third parties such as verifiers, certifiers, and lawyers.

There is certainly an overlap between transaction costs and institutional costs. For this study, we distinguished project level costs and national level REDD+ program costs. The Excel tool developed enables the projects and users to decide where to factor in these costs.

While some of the transaction costs occur only once – typically at the beginning of the project – others are periodical. The table below illustrates the transaction cost related processes of REDD+ projects.

Table 3: Transaction cost relevant REDD+ process

Step	Technical Outputs
Project Idea and Preliminary Assessment	Deforestation and degradation analysis (patterns & rates) Feasibility Assessment Project Idea Note
Project Design and Planning	Analysis of agents and drivers Preliminary definition of project boundaries Socioeconomic impact assessment Biodiversity impact assessment Program planning (logical framework) Non-permanence risk analysis
Development of Project Design Document (Carbon Accounting)	New methodology design (if applicable) VCS Project Description (= Project Design Document) Design monitoring plan (deforestation and degradation rates & patterns, emissions & removals, drivers, socioeconomic & environmental impacts) Harmonization with emerging governmental requirements and guidance
Development of Project Implementation Strategy	Reassess feasibility in light of technical outputs Development of with-project scenario and ex-ante estimates of emissions reductions
Financing and Investment Arrangements	Long-term financial plan
Approvals, Validation and Registration	Possible insertion into national accounting frameworks
Implementation and Monitoring	Monitoring Report (deforestation and degradation rates & patterns, emissions & removals, drivers, socioeconomic & environmental impacts) Loss Event Report (if necessary)
Verification and Issuance	Non-Permanence Risk Report Addressing Information Request (IRs) and Corrective Action Requests (CARs)

Source: Forest Trends (2011)

Table 4: Cost indicators of transaction costs for carbon finance projects under the Verified Carbon Standard (VCS)

Activity	Cost range
Feasibility study	US$ 20,000 – 35,000
Project documentation	US$ 70,000 – 150,000
Data collection	US$ 7,000 – 35,000
Validation	US$ 20,000 – 35,000
Registration fee	750 US$ per year
Initial verification	US$ 25,000 – 35,000
Ongoing monitoring	US$ 5,000 – 35,000
Ongoing verification	US$ 15,000 – 25,000
Issuance fee	US$200 for up to 1,000 tCO_2; US$ 0,05 per tCO_2 beyond that

Source: FAO, 2010 modified

4.6 Institutional Costs

Institutional costs of REDD+ are defined in the context of this study as costs incurred at the political-administrative level to develop, manage and enforce REDD+. These are typically costs incurred by government to ensure a positive legal and regulatory environment, address governance and reduce unregulated and/or illegal forest use. Furthermore in the context of REDD+, institutional costs are additional costs incurred by government institutions that are needed to reduce emissions from deforestation and forest degradation. Clearly, the term "additional" is somewhat difficult to define within this context. In an ideal world, where national and local government institutions fulfilled their legal mandates efficiently and effectively and were sufficiently well resourced to perform these tasks, there would be no "additional" costs, as deforestation and forest degradation rates would be close to zero. However, in a 'real-world context', government budgets are constrained, capacity is weak and failures in forest governance signify that illegalities are commonplace. Given the above, institutional costs in the context of REDD+ are largely concerned with strengthening measures designed to improve law enforcement, improve local forest management and strengthen forest governance.

4.6.1 Study approach to institutional costs

In this study we assume that institutional costs are partly covered by the projects and partly by the government. One part of the institutional costs are comprised of a national average value of US$ 0.011/ha/yr, which is based on the budgets of the Forest Carbon Partnership Facility's (FCPF) Readiness Preparation Proposal (R-PP) for Tanzania (R-PP, 2010). Data was used from the first four years of the REDD+ readiness and implementation phase equivalent to US$ 2.1 million over 4 years and extrapolated this budget over 30 years. The budget was divided by the total national forest area of 35.3 million ha. Optionally, only the forest area of REDD+ projects could have been used as reference. However, REDD+ is to be rolled out over suitable areas in the entire country. The REDD+ institutional framework should be an integral part of national forest policy and REDD+ contributes to a holistic concept and understanding of sustainable forest management at national level. Hence, we have opted to allocate costs to the whole forest area in Tanaznia.

The other part of the institutional costs are covered by the projects that assigned budgets to institutional capacity building of district level governmental staff and knowledge dissemination of lessons learned, which is an additional activity to build and strengthen REDD+ relevant institutions and capacity in Tanzania. The institutional costs did not differ significantly among project and amounted at US$ 0.06/ha/year for the Jane Goodall, US$0.07 for the TFCG Mjumita - Lindi project and US$0.05/ha/year for TFCG Mjumita – Kilosa.

4.6.2 Institutional analysis and involvement in REDD+

Forestry and Beekeeping Division & Tanzania Forest Service

The Forestry and Beekeeping Division (FBD) is a division within the MNRT. It has the overall mandate to protect, manage and conserve forest resources across mainland Tanzania and support beekeeping and trade in bee products. The forest sector is currently guided by the Forest Policy of 1998, which set the framework for a reorientation of forestry in Tanzania, away from a traditional top-down approach to one that facilitates local involvement in the management of forest resources. The National Forest Programme (2001 – 2010) provides the strategic framework for implementation of the Forest Policy through a series of "development programmes". The Forest Act (2002) provides the legal mandate for the FBD as well as legislating for the establishment of an autonomous forest management body (Tanzania Forest Service) and the creation of a Tanzania Forest Fund, through retention of 5% of all forest royalties and revenues. FBD is currently in a transition phase, following the official launch of the Tanzania Forest Service (TFS) in August 2011. It is expected that TFS will become fully operational by the start of the next financial year (2012/2013).

FBD/TFS oversees a national program of PFM – which covers two main approaches to engaging communities in forest management. Joint Forest Management (JFM) takes place within government forest reserves, and is legalized by the signing of a Joint Management Agreement, that defines the roles and responsibilities of the two parties regarding forest management. Community Based Forest Management (CBFM) takes place on village lands (outside forest reserves managed by central government).

FBD/TFS manages and directly supervises both forest production and forest protection in National Forest Reserves (covering about 12 million hectares or around 37 of the total forest estate). Forest law enforcement and the collection of forest revenues are also under the direct responsibility of TFS / FBD.

With regard to REDD+ FBD/TFS have been the most engaged national government institution in Tanzania, given their priority of forest management and protection. The current REDD Task Force draws members from 11 sectors / institutions, a. o. VPO, MNRT, PMO-RALG, other ministries, departments and civil society organisations. FBD / TFS is currently implementing a National Forestry Resources Monitoring and Assessment (NAFORMA) process, with support from the government of Finland and FAO. This has been expanded in scope to include a carbon baseline assessment, which will feed into and inform the process of MRV being established. Given their strong focus on forest management, FBD / TFS has been closely involved in the planning and execution of these projects.

The Wildlife Division

The Wildlife Division (WD) is the sister institution to FBD, being a division within MNRT. The Wildlife Division operates under the overall guidance of the Wildlife Policy (2007) and the Wildlife Conservation Act (2009). The Wildlife Division has the overall responsibility for the management of wildlife resources outside National Parks, (which fall under Tanzania National Parks Authority - see below). As with forestry, recent global moves towards a community-based approach to management of natural resources has resulted in Tanzania in changes in recent years and moves towards the creation of Wildlife Management Areas (WMAs). WMAs, located on village land, are established for the co-management of wildlife resources and to facilitate the sharing of benefits from sport hunting between the state and local communities.

A small secretariat established within the Wildlife Division, called the Wetlands Unit has overall responsibility for management of wetland resources in Tanzania and overseeing the implementation of the National Wetlands Strategy.

Despite the importance of the Wildlife Division with regard to management of carbon resources (and the relatively rapid depletion of carbon stocks in some areas under their responsibility), the involvement of the WD in discussions over REDD+ has been minimal to date.

Tanzania National Parks Authority (TANAPA)

The Tanganyika National Parks Ordinance [412] of 1959 established the organization now known as Tanzania National Parks (TANAPA), and Serengeti became the first National Park. Conservation in Tanzania is governed by the Tanzania National Parks Act (1970) and the Wildlife Conservation Act of 1974, which collectively allow the Government to establish protected areas and outlines how these are to be organized and managed. National Parks represent the highest level of resource protection that can be provided. TANAPA now manages 15 National Parks across a wide range of ecosystems in Tanzania. Nature-based or wildlife tourism is the main source of income that is ploughed back for management, regulation, and fulfilment of all organisational mandates in the National Parks.

Deforestation and forest degradation rates within National Parks are low relative to other areas of the country and as such, TANAPA have little to gain from a national REDD+ process. Furthermore, their significant level of income generated from tourism and relatively strong donor base means that their financial resource base is relatively secure, particularly when compared to other government institutions.

Division of Environment (Vice Presidents Office)

The Tanzania Environmental Management Act (EMA), which was passed in 2004 and became effective in 2005, provides the basic legal and institutional framework for the government of Tanzania's sustainable management of the environment. The EMA was developed following the passing of the Environmental Policy in 1997.

The EMA outlines principles for environmental management and the requirements for this - namely: impact and risk assessments, prevention and control of pollution, waste management, environmental quality standards, public participation, environmental compliance, and enforcement.

As defined in the EMA, two organisations share the institutional responsibilities for environmental management in Tanzania: The Vice President's Office/Division of Environment (VPO/DoE) is responsible for environmental policy making and government environmental management, while the National Environment Management Council (NEMC) is the technical entity responsible for enforcement environmental law, compliance, education and research. Both organisations are overseeing and coordinating the implementation of the EMA.

The EMA empowers VPO/DoE to take overall governmental responsibility for all matters relating to climate change and to act as the focal point (Designated National Authority) with regard to the UNFCCC. As such, VPO DoE is the apex body for both climate adaptation and mitigation efforts, and chairs the National Climate Change Steering Committee and National Climate Change Technical Committee.

National Environment Management Council

The NEMC was created in 1983 with a broad mandate in the area of environmental management. One of the most significant milestones in NEMC's history was the enactment of the EMA, which clarified the administrative and institutional responsibilities for environmental management in Tanzania. As a result of the EMA 2004, NEMC's mandate now encompasses several new important responsibilities and powers including environmental enforcement, compliance, environmental monitoring, research, managing of special areas awareness, and audits. Some of its previous responsibilities (related to policy formulation and coordination) were handed over to the DoE. Environmental impact assessment (including Strategic Environmental Assessment) is an important and growing area of work for NEMC

Following the clarification over division of responsibilities following the enactment of EMA, NEMC's role in the national REDD+ process to date has been very limited. However as the debate over potential positive or negative impacts of REDD+at local and national level develops, it is possible that NEMC may become more involved, given their involvement and mandate for overseeing Strategic Environmental Assessments (SEA). SEA is a central part of the World Bank's approved methodology for impact assessment and mitigation with regard to national programmes of this nature.

Institute of Resource Assessment (University of Dar es Salaam)

While the Institute of Resource Assessment (IRA) has no formal mandate with regard to REDD+, its role over the past 24 months has been central, in large part due to linkage with the Norwegian-funded national REDD+ process. IRA has been engaged as a national facilitator of the REDD+ readiness process and currently have a small REDD+ secretariat within the institute. A two-year funding support phase came to an end earlier in 2011 and a second two-year support grant was agreed in October 2011. Their main involvement to the national REDD+ readiness process has been to facilitate the work of the National REDD+ Task Force and to act as a secretariat to this group. They have convened task force meetings, commissioned consultants on behalf of the Task Force, and supported a series of consultative meetings, studies and reviews as well as facilitating international study tours. Traditionally IRA has played an important role within Tanzania with regard to remote sensing, GIS and aerial surveys. However, to date, MRV development has been focused within FBD and the involvement of IRA in this process has been minimal.

Prime Minister's Office – Regional Administration and Local Government (PMO-RALG)

The Prime Minister's Office – Regional Administration and Local Government (PMO-RALG) has overall responsibility for coordinating the activities and functions of local government authorities as well as supporting a national program of decentralization reforms. Based in Dodoma, PMO-RALG works primarily with district and municipal councils (which total 153) and regional administrative secretariats. Following the Local Government Act (1982), local governments became autonomous agencies and were no longer accountable to central government line ministries and agencies. This means that central government bodies such as FBD/TFS may only advise local governments by offering technical guidance and ensure compliance with national legislation, but are not in a position to provide direct instructions or orders to local government staff.

Given the importance of ensuring that REDD+benefits trickle down to the local level and that local level actors (such as farmers and villagers involved in PFM) are engaged in REDD, engaging local government authorities in the REDD+debate has been central. To date, there have been a series of consultative meetings during the preparation of the draft REDD+strategy. These have been held with district councils and local CBOs / NGOs. REDD+pilot projects are in general closely co-ordinated with the activities of local government staff such as District Forest Officers and District Lands Officers. Furthermore, the

Norwegian Embassy commissioned a short study to assess the feasibility of undertaking "district level climate change partnerships" which would demonstrate potential roles of district councils in benefit sharing mechanisms and their involvement and support to REDD+ processes at the local level. To date, these district level climate change partnerships have not materialized, although they are envisaged in the second phase of Norwegian support through IRA (see above).

National Land Use Planning Commission (NLUPC)

Since the mid-1990s, Tanzania has witnessed a series of reforms with regard to its land laws and policies. The National Lands Policy of 1995 provided the overall vision for the lands sector, and which was followed by the Lands Act (1999) and the Village Lands Act (1999). The Village Lands Act provides the legal basis for village governments to manage and adjudicate lands within the "village area". This includes land for agriculture, settlement, but also lands endowed with natural resources such as forests, grazing areas and rangelands. A key aspect of ensuring that village lands are used both rationally, productively and sustainably is village land use planning – a role which is under the NLUPC mandate and which was reinforced by the passing of the 2007 National Land Use Planning Act.

Village land use planning is seen as a central aspect of community based natural resource management on village lands, and is used when planning for community based forest management, sustainable wetlands management and wildlife management areas. Given recent concerns under REDD+ regarding possible "leakage" from forest areas under improved management, village land use planning has become even more important, and is central to all ongoing REDD+ pilot projects.

Given the rather narrow institutional focus of the REDD+ Task Force to date, NLUPC has not played any significant role in REDD+ readiness, other than consultations and advisory inputs with regard to land use planning tools and methods.

Ministry of Agriculture, Food and Co-operatives

Agricultural expansion is seen as one of the biggest drivers of forest loss in Tanzania and as a result, national and site-level REDD+ strategies will inevitably need to take account of current agricultural strategies as well support sustainable agricultural approaches in ways that minimize deforestation. Accordingly, the Ministry of Agriculture, Food and Co-operatives (MAFC) has been allocated a seat within the national REDD+ Task Force in 2012. The current national strategy for agriculture (Kilimo Kwanza), which has high level political support, emphasizes a transformation of the sector, away from non-productive subsistence level agriculture to a more modernized, commercially oriented sector. This will require expansion of commercial agriculture to non-farmed lands, an investment in mechanization and a heavy investment in infrastructure. All of these represent potential hot-spots for deforestation.

Ministry of Finance

The Ministry of Finance and Economic Affairs manages the overall revenue, expenditure and financing of the Government of the United Republic of Tanzania and provides the Government with advice on the broad financial and economic affairs of Tanzania in support of the Government's economic and social objectives. The Tanzania Revenue Authority is under the overall supervision of the Ministry of Finance and has responsibility for tax policies and collection.

Given that REDD+ is in effect an instrument that facilitates the transfer of funds internationally as well as internally within a given country, the involvement of the Ministry of Finance is critical in discussions around the emerging REDD+ architecture and in particular with regard to the establishment of a national REDD+ Trust Fund and benefit sharing modalities and procedures. To date, Ministry of Finance involvement in the REDD+ debate has been limited. It is anticipated that as proposals in these key areas become increasingly concrete, their involvement will grow.

International and National NGOs

The natural resource and environmental sector in Tanzania has historically been well supported by both national and international NGOs, in large part due to the biodiversity and conservation importance of the country as a whole, but also due to the pressing and growing environmental challenges that the country faces as it develops.

A number of national and international NGOs are currently engaged in the implementation of pilot projects in different parts of the country, with the objective of testing and piloting approaches to making REDD+ operational on the ground. Other NGOs are more directly involved in advocacy efforts such as Tanzania Natural Resource Forum (TNRF) and Tanzania Forest Conservation Group (TFCG). These advocacy processes are largely directed towards a domestic audience, but are also being undertaken within international forums such as UNFCCC meetings and other climate change platforms.

4.6.3 Capacity, staffing and budgetary allocations

Forestry Beekeeping Division / Tanzania Forest Service

As indicated earlier, the forest sector is in transition at present, with TFS formally launched but currently not operational. It is anticipated that TFS will become operational by the start of the FY 2012/13 (July 2012). One of the key changes resulting from a transition from a division to an executive agency is the ability to retain and reinvest forest funding. Under current arrangements, while FBD is a major income earner for Treasury, it is not able to retain any of these funds. Instead it operates a "retention fund", which officially allows FBD to retain 66% of all forest royalties. This is, however, a fund in name only, as all revenues are remitted to Treasury, and very limited funds are sent back to FBD for recurrent costs.

Under the TFS model, all revenues from forest utilization, licensing and royalties will be retained. Current levels of revenue collection are in the order of TSh 35 billion / year (approximately US$ 21 million). Retaining even half of these funds would transform forestry administration and allow significant levels of investment in forest development, protection and conservation.

At present, a relatively small forest fund – known as the Tanzania Forest Fund (TFF) – has been established, as mandated by the 2002 Forest Act. This allows 5% of forest revenues to be retained at source and allocated to forest development across Tanzania. The projected budget for this fund for the current financial year is approximately TSh 5 billion (approximately US$ 3 million), which represents a significant level of support. The fund has only recently become operational and allocates grants primarily to Tanzania Forest Service / FBD, but potentially could also allocate funds to local governments and NGOs working in the forest sector. Operational guidelines have yet to be developed for this and as such, allocations are currently only made to FBD / TFS. The TFF is overseen by a board, most of whom are drawn from government agencies (such as MNRT, SUA and Ministry of Finance). Plans are being made to expand membership from NGOs and civil society. During this financial year, 46% of the total budget has been allocated in support of law enforcement and forest protection. This will include support to forest check points, removing human settlements from within forest reserves, support to Forest Support Units (FSUs) and participation in Forest Law Enforcement Governance and Trade (FLEGT) processes.

The current financial year budget for TFS is TSh 26.498 billion (around US$ 16.06 million). This represents a significant growth in budget from the previous FY before TFS had been launched. It is not clear what the actual allocation to TFS will be during this FY, as the institution has yet to obtain full financial autonomy and is still dependent on Ministry of Finance. A review of the budget indicates a significant investment in support to law enforcement activities (including a proposed expansion of the capacity and operations of the FSUs, checkpoints and forest management at the reserve level. The current budget has a provision of TSh 1.6 billion for payment of staff salary and payroll liability for 1800 staff. However, it is rather unclear whether these staff have yet to be formally transferred to TFS, or whether they operate under the former system where all staff were paid by the Public Sector Commission (as with all civil servants).

Following the operationalisation of TFS, FBD will continue to exist in some form or other, although it has yet to be fully established. It is most likely that any remaining or residual staff will be absorbed into the MNRT, within the Department of Policy and Planning. The role of these staff will be one of oversight, ensuring policy compliance, monitoring and regulation. All operational roles (including forest law enforcement and protection) will be transferred to TFS. Given this reduction in functions, the number of FBD staff is expected to shrink down to around 15. The approved budget for FY 2011/12 for FBD totals TSh 6.6 billion (US$ 3.5 million). The bulk of these funds have been allocated to support other forest institutions such as the Tanzania Forest Research Institute (TAFORI), Forest Training Institute (FTI), Beekeeping Training Institute, Tanzania Tree Seed Agency and others.

Vice President's Office – Division of Environment

In 1995, the DoE had eight staff members. In April 2008, this had increased to 57 (including 38 technical staff and 19 support staff), all based in Dar es Salaam. In 2007, DoE submitted a proposal to the President's Office – Public Service Management for the Division's expansion and organisational restructuring. The request for restructuring was declined, but fifteen new positions were approved and have been filled. All 38 technical staff are university graduates (29 have Masters degrees; three have PhDs) and have formal academic training in a wide variety of areas including environmental sciences, town planning, education, livestock, law, agriculture, fisheries, economic, mining, engineering and forestry. Approximately one-third of all DoE staff members are women: 9 technical staff (24%) and 6 support staff (32%).

A profile of DoE's technical staff in 2005 and 2008, provided in the table below, shows how DoE has grown since EMA became operational.

Table 5: Profile of DoE technical staff by section

Section	Number of Technical Staff (2005)	Number of Technical Staff (2008)
Environmental Natural Habitats Conservation	12 (4 women)	13 (4 women)
Environmental Management of Pollution	10 (3 women)	12 (3 women)
Environmental Impact Assessment	13 (2 women)	13 (2 women)

Source: Universalia. 2009. Institutional assessment of the Division of Environment

As shown in the following table, DoE's revenues have increased significantly since 2004, rising from a budget of around TSh 5.1 billion to almost TSh 16 billion in 2008/09. An increasing share of the budget is being sourced from the Government of Tanzania.

Table 6: DoE's revenues break down

Sources of Revenue	2004/05		2007/08		2008/09	
	TSh (000)	% of Total Budget	TSh (000)	% of Total Budget	TSh (000)	% of Total Budget for Tanzania
Government	306,400	5.9	4,195,019	30	6,390,282	37.6
Fees and Taxes	0.00	0.0	2,133	0.01	3,653	0.02
Donors	4,879,300	94.09	9,781,700	70	10,599,180	62.4
Total	5,185,700	100	13,978,842	100	16,993,115	100

Source: Universalia. 2009. Institutional assessment of the Division of Environment

Local Government Authorities (LGAs)

Staffing numbers and capacity

There are 106 rural districts in Tanzania and staffing numbers, capacity and budgets vary enormously across the country. The figures provided in this section are derived from a series of studies undertaken over the past 10 years, which have aimed to provide insights into staffing levels and budgets at district level within the arena of natural resources management.

The Eastern Arc Mountains Conservation and Environment Project (funded by UNDP-GEF) undertook a baseline assessment[1] of staffing capacity in 2004, where they assessed the total amount of staffing and revenues available at district level across 14 Eastern Arc districts in eastern Tanzania and southern Tanzania.

This review established that there were 79 district-employed foresters (making an average of 5.6 foresters / district) and 69 catchments forest staff (central government staff operating at local level to protect central-government administered catchment forests) making an average of 4.9 foresters /district. It may be inadvisable to extrapolate these figures across the whole of Tanzania – mainly because the study is outdated and the presence of central government staff (catchment foresters) is known to be higher in this region due to the presence of catchment forests. Other parts of the country with less important forest resources may have fewer or no central government staff working on forest conservation locally.

[1] Burgess. N and Kilihama, F. 2004. Is enough being invested in Tanzania's Eastern Arc Mountains? Arc Journal. Issue 17. Tanzania Forest Conservation Group. Tanzania

The same review found that staffing levels and capacity were much higher within TANAPA-administered National Parks (such as Mikumi and Udzungwa National Parks).

Districts within the Eastern Arc landscape had 1.75 vehicles / district, 3.5 motorbikes/ district, 1.1 computers / district and 0.3 photocopiers per district. It is likely that these figures have increased since this review was done in 2004, given additional support provided by PFM and others.

Local government budgets

A study carried out by WWF's Coastal Forest Management Programme[2] undertook a review of budgets and revenues in three coastal districts – namely Rufiji, Kilwa and Lindi. They established financing sources from the following three areas: Central government funding to local governments, local government internal funding and donor / NGO support.

Central and local government allocations to districts varied as seen in the table below and have been calculated based on per ha cost (reserved and unreserved forests – figures from FBD).

Table 7: Budgets of selected districts

	Rufiji		Kilwa		Lindi	
Funding source	US$	US$ / ha	US$	US$ / ha	US$	US$ / ha
Central government support	13,300	0.010	22,000	0.017	12,328	0.016
Local government internal support	12,000	0.009	18,687	0.014	14,667	0.018

Source: WWF's Coastal Forest Management Programme

In the Eastern Arc study (mentioned above), the total revenue provided across all Eastern Arc districts was found to be about 54,000 US$. It would seem that even in US$ terms this figure has increased, when compared to those given from coastal areas in 2011.

Local government revenues from forests and forestry activities

Revenues are collected by local governments based on harvesting and transport of forest products from central government forest reserves and un-reserved forests on village lands. WWF undertook a study of revenues in the same three districts and the figures are presented

[2] Shemdoe, RS and Abdallah, JM. 2011. Socio-economic baseline surveys for selected coastal forest landscapes in Tanzania. WWF Tanzania

below. The figures have been adjusted to show revenue generation per hectare of forest within the district (FBD figures)

Table 8: Forest revenues in selected districts

Forest Revenues generated	Rufiji		Kilwa		Lindi	
	US$	US$ / ha	US$	US$ / ha	US$	US$ / ha
	733,000	0.58	82,000	0.064	47,162	0.060

A study conducted on behalf of the Danida PFM programme established that Kilosa district generated 317 Million TSh from charcoal royalties alone (not including other potential revenues from timber etc). This comes to around US$ 192,000 and represents about 0.83 US$/hectare generated from forests.

4.6.4 Institutional costs associated with REDD+

The following table provides data gathered by the authors covering the two main types of costs. Firstly, data is presented on the institutional costs required to support participatory forest management. This does not include staffing costs or other recurrent costs associated with these staff, but the direct costs associated with bringing trained facilitators to the field to support communities in the development of forest management plans, bylaws and local institutions. Data is provided for processes facilitated by local and national government agencies, as well as NGOs.

The source of this data presented below is largely from government, NGO and donor-funded projects. Data is generally derived from budgets, rather than actual spend, as in general this information is more readily available. In the instance of the Danida-supported PFM program, however, figures are presented based on actual costs following a detailed analysis conducted towards the end of the previous phase of program support.

The data for government-led processes shows that costs per hectare vary widely across different districts. This was due to a number of factors. On one hand, districts worked at very different levels of scale. Some districts concentrated on a limited number of smaller forest sites, while others chose larger forest blocks. Furthermore, some districts had greater areas of forest within their administrative boundaries and had a wider choice of options when selecting areas to work. Finally, some districts invested significantly in capacity building and awareness raising before embarking on PFM, as existing capacity and understanding was low.

For the purpose of this study, we used a simplified approach, as outlined in chapter 4.6.1. Nonetheless, the following tables shall give an overview over all costs project implementers and REDD+ framework designers could consider when planning and implementing REDD+. Whether these costs should be allocated to REDD+ in a full cost estimate depends on the individual REDD+ projects conditions. E. g. PFM (see **Table 9: Institutional costs associated with establishing participatory forest management**) is officially a national programme in Tanzania, independently implemented from REDD+. However, it has only been implemented in parts of the country. Thus, REDD+ projects in areas where PFM has been implemented (either by government or NGOs) can draw on already existing community structures, while other projects have to develop these structures under their own budget.

Ongoing enforcement of forest law and national forest management programs are crucial for successful implementation of REDD+. Again, in areas where these activities are not implemented, REDD+ projects have to consider these activities under their own project design (thus, these costs are project implementation costs). In areas, where the state is successfully implementing these activities, project can draw on a existing structures. The costs calculated in the following tables are presented to enable comparability projects with varying pre-conditions, although these costs are incurred independently form REDD+ and are not additional.

Table 9: Institutional costs associated with establishing participatory forest management

Item	Initial cost in US$/ha until PFM structures are established	Source	Notes and assumptions
PFM Establishment Costs – at district level (when implemented by local governments)	13.3 US$/Ha	Financial data (actual spend) from Danida-supported PFM programme	Cost per hectare of legally establishing PFM (both CBFM and JFM) up to final stage of legalization. Reflects costing of PFM establishment costs across 18 districts supported by Danida between 2003 and 2009. Establishment costs cover costs of setting up PFM – but not maintaining it in medium term. These costs drop. Exchange is BoT rate of 5 Dec. 2011 equal to 1,651.7 TSh = 1 US$
PFM Establishment costs – national level management costs and	1.77 US$/ha	Financial budget figures provided by Danida supported PFM	Actual costs of supporting national enabling framework (including technical assistance) and then divided by the total

overheads		programme	actual PFM area (1,996,053 Ha) including both CBFM and JFM. Exchange is BoT rate of 5 Dec. 2011 equal to 1,651.7 TSh = $1 US
PFM Establishment Costs at local level when implemented by International NGO	22.5 US$/ha	Financial budget worksheets from JGI and Mpingo Conservation Project	Average cost of US$ 22.5 US masks the variation between US$ 10.65/Ha for MCI and US$ 34.3/Ha for TFCG

The average cost/ha of the government program in Danida-supported districts was 13.3 USD/ha. For those districts that were able to "complete" PFM process in > 75% of sites, the cost rises to US$22.9. The costs of NGO-facilitated PFM within REDD+ pilots sites varied significantly from US$ 10.6 – 34.3, but with an average of US$ 22.5/hectare. Consequently the costs of district-facilitated PFM processes compared favourably with those of NGO-facilitated processes and on average prices were largely similar.

When costs were analysed on a "per village" rather than "per hectare" basis a greater degree of similarity occurred across institutional types. When facilitated by local governments (under Danida support), the average cost per village US$ 3,928/Village. This figure rose to US$ 5,374, when selecting districts that had completed PFM establishment in at least two thirds of the villages selected for support. One potential explanation for the relatively low variation in costs between districts when analysed per village is due to the fact that many of the costs of PFM establishment are focused on the village government (supporting the establishment and training of village natural resource management committees, preparing management plans and bylaws) and are less determined by considerations of area.

There were significant differences in costs between district-facilitated and NGO-facilitated PFM processes. The average cost per village for NGO supported processes was US$ 20,886 / Village, again, with relatively low levels of variation (figures ranged US$ 22,498 / Village to US$ 19,294 / Village).

When the implementation costs of introducing PFM are combined with additional costs of supporting a broader process of rural development, through for example, sustainable agricultural intensification and reducing demands for charcoal the cost per hectare rises significantly, up to an average cost of US$ 84/hectare. This combination of PFM plus integrated rural development is likely to be a common characteristic of REDD+ projects in Tanzania, so costs in this area are likely to be typical.

Additional data is provided for institutional costs related to general forest management (recurrent costs) strengthening forest law enforcement, improving the management of government-administered forest reserves and introducing independent forest monitoring. All of these are costs that are essential costs required to ensure effective forest management at the national level.

Table 10: Recurrent costs of forest management and protection

Item	Annual cost in US$/Ha	Source	Notes and assumptions
PFM Recurrent costs (patrolling) as seen from village level	2.39 US$/ha	Financial budget figures from Jane Goodall International REDD+ proposal	Training of Community Monitors budget from detailed budget for 70,000 ha of forest as expressed in JGI REDD+ Proposal
PFM Recurrent costs (from district perspective)	0.0134 US$/ha	Kilwa Financial Scorecard	Data compiled in June 2011 by DFO Kilwa. TSh 10,000,000 required patrolling 450,000 ha forests on public lands in Kilwa.
Forest Reserve Management Costs (actual)	2.3 US$/ha	Jonathon Green Paper3	This figure represents actual spend across Eastern Arc Mountain forest reserves managed by central government
National Park Management Costs (actual)	7.7 US$/ha	See above	Actual costs/ha for management of national parks
Forest Reserve Management Costs (required)	8.3 US$/ha	See above	Estimated cost of effective forest management, as expressed by forest reserve managers
Amount needed to manage forests and	3.64 US$/ha	Moore et al, 2004	Figure provided for generic African

[3] Jonathan M. H. Green, Neil D. Burgess, Rhys E. Green, Seif S. Madoffe, Pantaleo K. T. Munishi, Evarist Nashanda, R. Kerry Turner, Andrew Balmford. Estimating management costs of protected areas: a novel approach from the Eastern Arc Mountains, Tanzania. Paper submitted to Biological Conservation (under review)

protect them adequately			Montane forest habitats – not Tanzania specific

The figures above provide a number of important findings. The costs of effective forest management, as estimated by Tanzania Forest Service (TFS) is US$ 8.3 per hectare, but current budget constraints mean that current expenditure is around US$ 2.3 per hectare. This compares with US$ 7.7 per hectare, being the actual revenue spent by Tanzania National Parks Authority (TANAPA) to manage forest areas under their jurisdiction. The estimate of recurrent forest management costs by communities for areas under PFM is $2.3, which is just over a quarter of the estimated costs of effective management defined by TFS.

Table 11: Law enforcement and surveillance costs

Item	Annual cost in US$/Ha	Source	Notes and assumptions
Total law enforcement costs from FBD/ TFS	0.043 US$/ha	Tanzania Forest Service, National Forest Programme and Tanzania Forest Fund Budgets	Figure derived from total law enforcement budget of FBD / TFS divided by the total estimated area of forest Exchange is BoT rate of 5 Dec. 2011 equal to TSh 1,651.7 = 1 US$.
Cost of running Forest Surveillance Units	0.001 US$/ha	Tanzania Forest Service, National Forest Programme and Tanzania Forest Fund Budgets	Figure derived from Forest Surveillance Units budgets of FBD / TFS divided by the total estimated area of forest. Exchange is BoT rate of 5 Dec. 2011 equal to TSh 1,651.7 = 1 US$.
Required costs of running Forest Surveillance Units effectively	0.002 US$/ha	Tanzania Forest Service Budgets	TFS budget for 50% effectiveness is TSh 577,479,400 for 35.3 million hectares of Tanzania's forests (equal to TSh 16.36/Ha or $ 0.001/ha). Assumed double the budget would suffice for 100% effectiveness. Hence TSh 0.002/Ha
Costs of Independent Forest Monitoring (to increase law enforcement and improve forest governance)	0.029 US$/ha	Data from feasibility study on Independent Forest Monitoring (IFM) carried out by REM (UK)	Initial costs are highest (over 1 M / year) and dropping off 1 Million US$ / year – covering all of Tanzania Divided by 35.3 million Ha of forests in Tanzania

The figures above suggest that forest law enforcement and improved governance may represent significant costs when seen from the national level, but when expressed as per hectare costs are relatively minor, when compared with other institutional costs.

5. REDD+ Costs Tool

An Introduction to the Excel-based Tool

Conceptually the REDD+ costs analysis is based on the World Bank training manual *Estimating the Opportunity Costs of REDD+* (2011). The analysis in this study used a bottom-up approach to estimate REDD+ cost elements whereby project specific secondary data on land use changes, carbon stocks and costs / benefits of existing land uses was collected from three Tanzanian REDD+ pilot projects and one PFM area (in total four project locations). For the estimation of REDD+ cost elements we developed an Excel-based tool that allows estimating cost elements in a consistent manner and provides input data masks that can be linked with the REDD ABACUS software[4], a visualisation tool for opportunity cost curves that was developed by the World Agroforestry Centre.

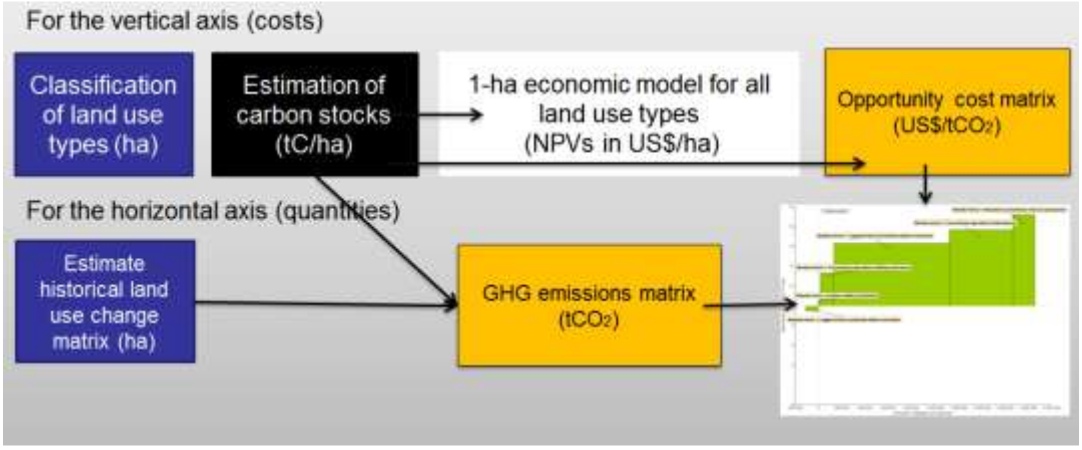
In general the design of an opportunity cost curve includes the analytical steps as shown in Figure 8 below. The development of the opportunity costs requires four major steps:

i. the classification of the current land use types at the project start and an analysis of the historical land use changes that relates to a detailed analysis of the drivers of deforestation in the respective project area;
ii. analyzing the long-term average carbon stocks of the identified land uses;
iii. estimation of the annual cash flow and the net present value of the identified existing land uses; and
iv. the generation of an opportunity cost curve with ABACUS.

Detailed explanation of input parameters and interpretation of output data is given in Annex I.

[4] http://www.worldagroforestry.org/sea/abacus

Figure 8: Analytical steps to develop an opportunity cost curve

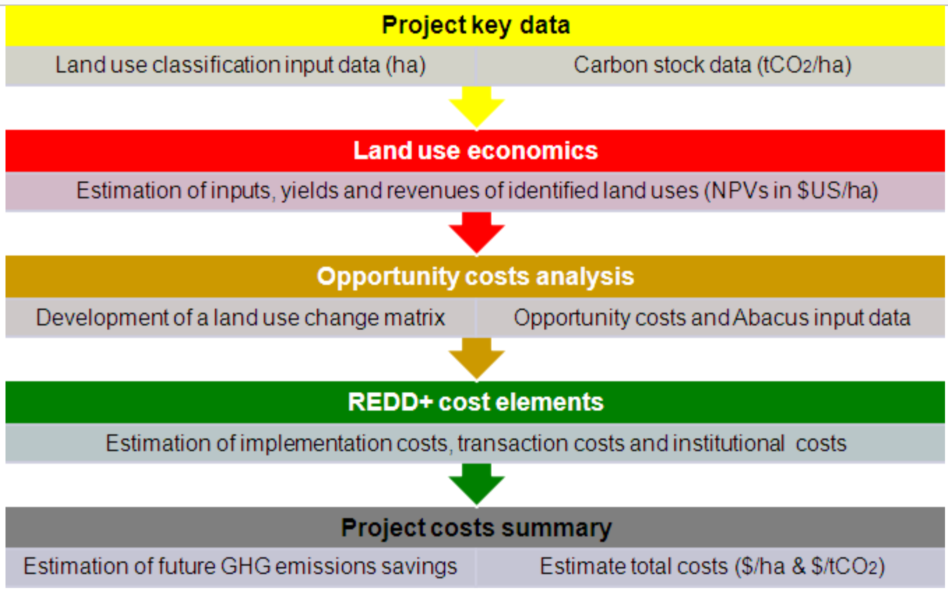


Source: Adapted from World Bank (2011)

After the establishment of opportunity cost curves other REDD+ cost elements are estimated, including implementation costs, transaction costs and institutional costs. The data for the implementation and transaction costs is used from budgets of the respective REDD+ pilot projects. For the estimates of institutional costs that are not incurred by the project developers but are reflected in the national budgets to build institutions, design and implement a national REDD+ framework, we used the national budgets of the national REDD+ readiness and implementation budgets to estimate institutional costs.

For the presented analytical steps we developed an Excel-based tool that provides key input data for ABACUS to design opportunity costs curves. The tool is based on five major components as illustrated in Figure 9 following the analytical steps mentioned above. In the next sections each step is elaborated in detail with examples from the REDD+ cost element Excel tool.

Figure 9: Excel-tool conceptual framework to estimate REDD+ cost elements



6. Costs of REDD+ Pilot Projects

A Summary of the Results

This section summarizes the results of the comparative study on the five REDD+ and SFM project cases as shown in Table 12: Characteristics of selected pilot projects, representing a total area of over 358,000 ha. Following the analytical stepwise approach, as described in the previous chapters we present the key input data on the four project cases that were used to estimate the costs of REDD+ pilot project, followed by the carbon stock assumptions and the economics of the project specific land use systems.

We present and interpret the opportunity costs curves for three projects that were subject to historical deforestation and forest degradation and comparatively estimate cost elements of the project. All assumptions are based on a project lifetime of 30 years, as proposed in most project cases. Cost elements of projects with a shorter project lifetime were extrapolated to a period of 30 years aiming to maintain consistent comparability of the projects.

6.1 Selected REDD+ pilot projects

After identification of the four pilot projects that will be considered in the analysis it appeared that only three projects can be classified as REDD+ projects: the Jane Goodall Kigoma project, as well as the two TFCG projects in Mjumita Kilosa and Lindi. The Mpingo Conservation and Development Initiative (MCDI) can be classified as a carbon stock enhancement project without significant historical deforestation pressure that will enhance carbon stocks, as shown in Table 12: Characteristics of selected pilot projects.

Table 12: Characteristics of selected pilot projects

	Jane Goodall Kigoma project	TFCG Mjumita project - Kilosa	TFCG-Mjumita project - Lindi	Mpingo Conservation and Development Initiative
Project type/activities	REDD	REDD	REDD	SFM
Total project area (ha)	85,200 ha	148,825 ha	93,800 ha	30,000 ha
Major drivers of deforestation	Unsustainable timber extraction; Unsustainable fuel wood collection; Shifting cultivation; Pasture (grazing cattle)	Unsustainable charcoal production; Shifting cultivation	Unsustainable charcoal production; Shifting cultivation	No significant drivers of deforestation, regular fire may be driving force, but, reference emissions level not assessed, yet.

6.2 Carbon Stocks of Pilot Projects

For the five project cases we used project-specific carbon stock estimates. For the analysis of the opportunity costs all identified land use systems including natural forest and all drivers of deforestation and forest degradation are assigned a long-term average carbon stock value (30 years). Unsustainable land use such as timber extraction, charcoal and fuelwood collection is assumed to be converted to shifting cultivation over a certain period of time, depending on the project. The table below presents the carbon stocks for all four project cases.

Table 13: Carbon stocks estimates for opportunity cost analysis (tCO_2/ha)

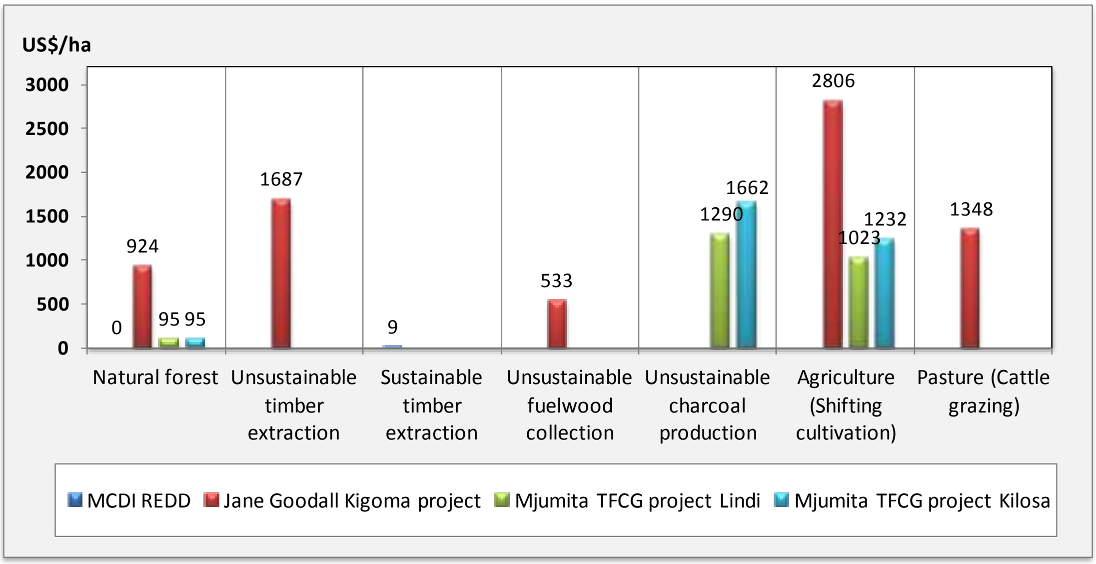
	Jane Goodall Kigoma project	TFCG Mjumita project - Kilosa	TFCG-Mjumita project - Lindi	Mpingo Conservation and Development Initiative
Natural forest	80.6	145.3	158.6	73
Unsustainable timber extraction	30.2			
Sustainable timber extraction				110
Unsustainable charcoal production		16.1	53.8	
Unsustainable fuel wood production	30.2			
Agriculture (Shifting cultivation)	15.4	16.1	53.8	
Pasture (Cattle)	22.2			

Note: Projects are planning to use different carbon pools to account for potential GHG emissions reduction and removals: Jane Goodall Kigoma project: Accounting of above-ground and below-ground biomass based on the average carbon stock as identified in the Ground Forest Carbon assessment of the Masito Ugalla Ecosystem Pilot area (Zahabu, 2011) and Fisher et al, (2011); TFCG Mjumita – Kilosa: Long-term average aboveground carbon stocks are based on a weighted average carbon stock from 17 forest plots randomly distributed across the project area. Belowground carbon stocks are based on IPCC default root-to-shoot ratio for dry tropical forest; TFCG Mjumita – Lindi: The long-term average is based on the average aboveground and belowground carbon stock from TFCG Mjumita project staff derived from field surveys; Mpingo Conservation and Development Initiative: The project accounts only for aboveground carbon stocks and the long-term average carbon stocks are based on data from Mpingo project staff and the assumption that the conversion of natural forest to sustainable timber extraction will result in an increase of 37 tCO_2/ha over a period of 30 years.

6.3 Land use economics of pilot projects

The land use economics were based on the calculation of the average annual cost and revenues of the identified land use types existent in the project areas. All costs and prices are based on the farm-gate level. For the determination of the Net present value we used a discount rate of 10% and calculated the NPV for a period of 30 years. The figure below presents the NPVs for all projects and existent land use types. Each color indicates one project. The key input data for all land uses are presented in the project specific summary reports.

Figure 10: Opportunity costs of land uses in the selected pilot projects



Compared to the other projects the Jane Goodall Kigoma Project has the highest NPV for all land use types. The NPV for natural forest amounts at US$ 924/ha, while shifting cultivation is the most profitable business in this region with a NPV of US$ 2,806/ha. This indicates that the avoidance of converting natural forest to shifting cultivation will comprise the highest opportunity costs. Only unsustainable fuel wood collection (US$ 533/ha) is less profitable than natural forest use that will result in long-term net GHG benefits and economic benefits when avoiding this land use type.

In contrast the Mpingo Conservation and Development Initiative, where historically no deforestation pressure and no forest use has taken place, has a NPV of US$ 0/ha for natural forest. With the implementation of the sustainable forest management activities the NPV will increase to US$ 9/ha resulting in net GHG benefits and economic gains in the long-term. In the TFCG Mjumita Lindi and Kilosa projects, the NPVs indicate relatively high opportunity costs to avoid the conversion of natural forest (US$ 95/ha) to unsustainable charcoal (US$ 1,290 for Kilosa and US$ 1,662/ha for Lindi); and shifting cultivation (US$ 1,023/ha for Kilosa and US$ 1,232/ha for Lindi).

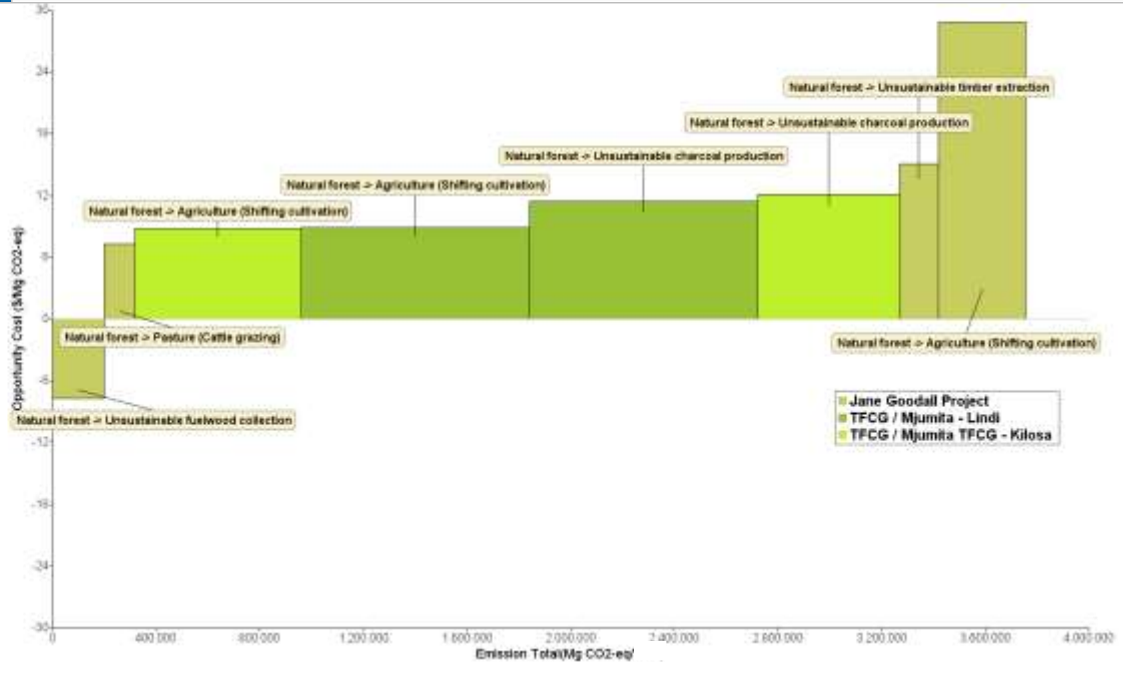
6.4 Opportunity costs curve for REDD+ pilot projects

Using the carbon stock data, the NPVs for the respective land uses and the deforestation rates over the past 10 years of each project we constructed an opportunity cost curve using the ABACUS software. The opportunity costs curve allows us to view and compare the foregone benefits of the analyzed projects and land uses if avoiding the conversion of natural forest to other land use types.

Box 3: How to read the opportunity cost curve

- Each bar represents an option of avoiding GHG emissions from converting natural forest to another land use type.
- The width of each bar shows the GHG emission reduction/carbon removal potential (in tCO_2 over a period of 10 years taking into account the current economic conditions and assuming that the deforestation will occur in the same manner as in the past 10 years.
- The sum of all bars cumulates the total GHG emission reduction potential over a period of 10 years (tCO_2) from all projects.
- The height of each bar shows the opportunity cost for avoiding the conversion of one land use to another (US$/$tCO_2$).
- The bars on the left hand side represent the cheapest emission reduction options, while the bars on the right hand side comprise the most expensive GHG emission reduction options. Thus, avoidance of land use changes on the left hand side provide relatively cheap GHG emission reduction potential and serve as a crucial basis to prioritize cost-effective measures to avoid deforestation.
- Each colored bar represent one distinct REDD+ project.

Figure 11: Opportunity cost curve for three pilot projects

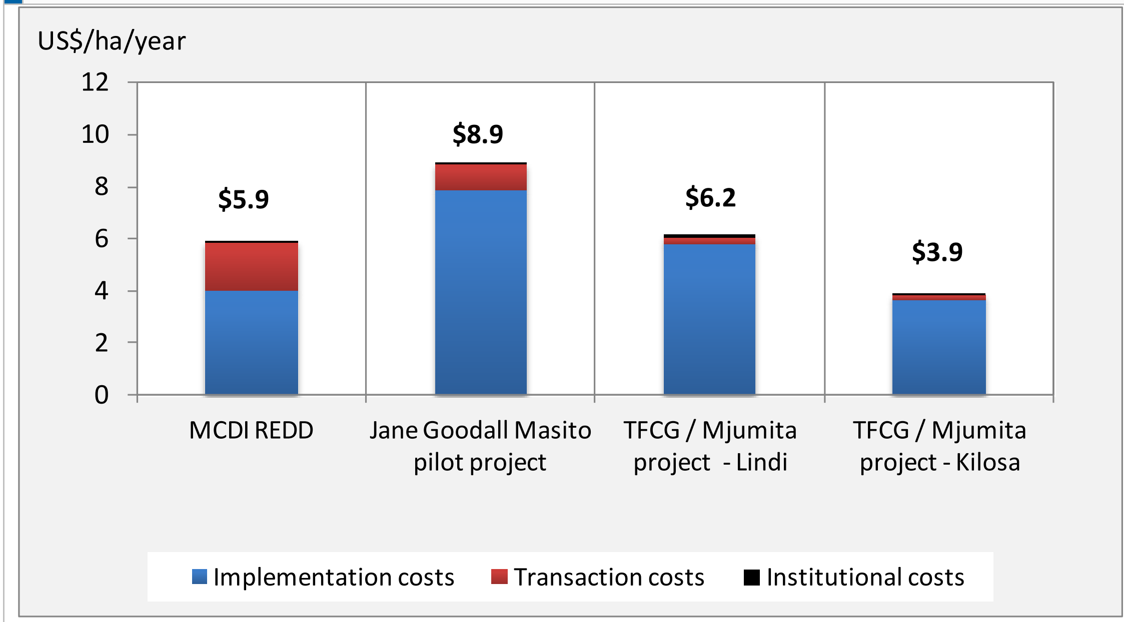


The opportunity costs curve was developed based on three REDD+ projects that have experienced historical deforestation. The three projects represent a total area of 328,000 ha. The cost curve depicted in Figure 11 above shows all land use changes that occurred over the past 10 years in the project areas. It shows that the Jane Goodall project in Kigoma has four major drivers of which two can be avoided at low opportunity costs and two are relatively expensive. The avoidance of unsustainable fuel wood collection has negative opportunity costs (US$ -7.8/tCO_2) and avoiding the conversion of natural forest to pastoral land would cost (US$ 7.3 tCO_2). Both measures could avoid about 0.32 MtCO_2 over 10 years. In contrast, the avoidance of land use shift towards unsustainable charcoal production and unsustainable timber extraction are the most expensive measures creating opportunity costs of US$ 28.8/tCO_2 and US$ 15.1/tCO_2 respectively, and could avoid emissions of about 0.49 MtCO_2. In the TFCG Mjumita Lindi project the avoidance of land use change towards shifting cultivation and unsustainable charcoal production comprises opportunity costs of US$ 8.9/tCO_2 and US$ 11.4/tCO_2 respectively and could reduce emissions by 1.76 MtCO_2 over a period of 10 years. In the TFCG Mjumita Kilosa project opportunity costs for shifting cultivation would amount US$ 8.8/tCO_2 and for unsustainable charcoal production US$ 12.1/tCO_2. In total, the avoidance of converting natural forest to these land uses has the potential to reduce emissions by 1.2 MtCO_2 over 10 year.

6.5 REDD+ cost elements of pilot projects

In this sub-section we present the REDD+ cost elements namely implementation, transaction and institutional costs. Moreover, institutional costs will arise that are not paid by the project developers, but are included in the national budgets of the REDD+ readiness and implementation plans under the framework of the FCPF with a budget of US$ 2.1 million between 2010 and 2013. For the implementation and transaction costs we used the annual budgets of the projects and calculated the annual average costs per ha for each project, ranging between US$ 2.4/ha to US$ 8.9/ha as shown in Figure 12 below. The bulk of all cost is comprised by implementation costs in each project, while institutional costs and transaction costs have a relatively insignificant share ranging between 5 % (TFCG / Mjumita - Lindi) and 11 % (Jane Goodall Kigoma) of total annual costs/ha. Only the Mpingo Conservation and Development Initiative Conservation and Development Initiative has a larger share of transaction and institutional costs, amounting at 32 % of total costs/ha. The latter reflects the overall low project costs and benefits.

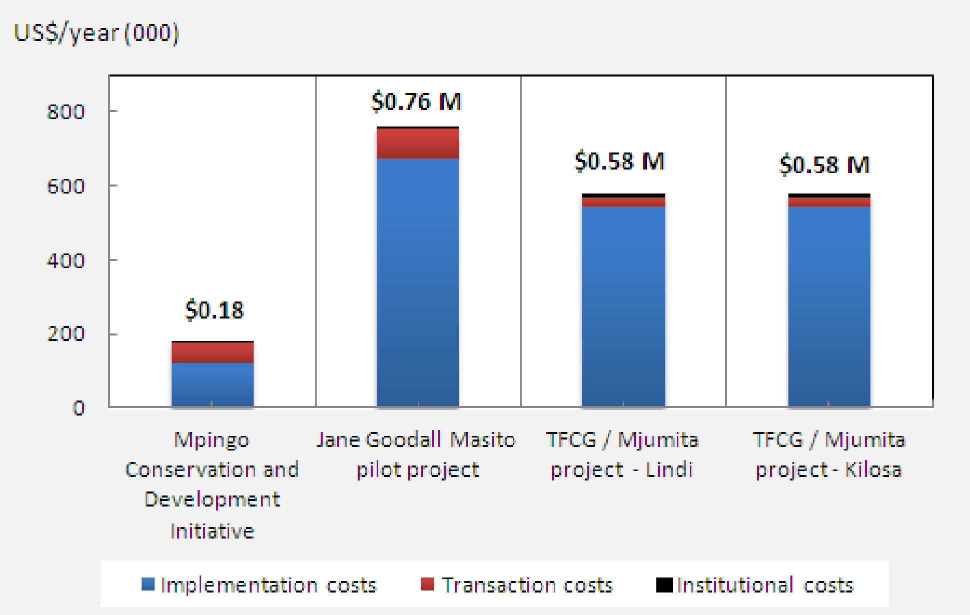
Figure 12: Annual average project costs/ha



Taking into account the different scales of the project, the annual average costs for each project are shown in Figure 13 below, ranging between US $0.18 million for the 30,000 ha Mpingo Conservation and Development Initiative and US$ 0.75 million for the 85,200 ha large Jane Goodall Kigoma project. At current costs without taking into account inflation, the

Mpingo Conservation and Development Initiative will cost US$ 5.4 million over 30 years; Jane Goodall Kigoma US$ 22.7 million; TFCG Mjumita Lind and Kilosa each US$ 17.4 million.

Figure 13: Total annual average costs

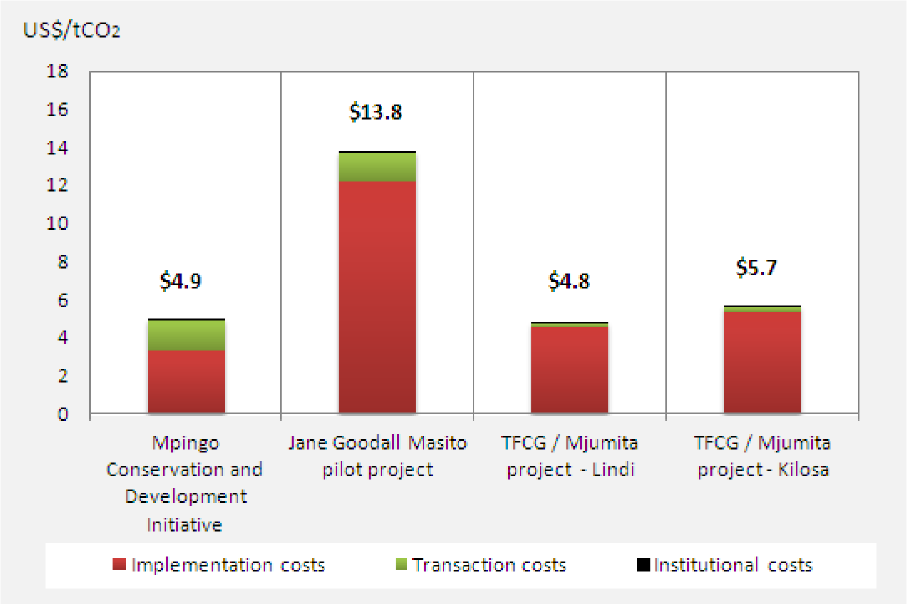


6.5.1 Total costs per avoided tCO_2

Taking into account all four cost elements of the project and using the GHG emission reduction/removal estimates, we calculated the cost for each avoided tCO_2 emission or removal.

The total costs range between US$ 4.8/tCO2 for the TFCG Mjumita Lindi project and US$ 13.8/tCO_2 for the Jane Goodall project. In our calculation we did not add the opportunity costs to the total project costs as we assume that with project implementation opportunity costs will be reduced through alternative income generating activities.

Figure 14: Costs to avoid 1 tCO_2



7. Towards a National REDD+ Cost Curve

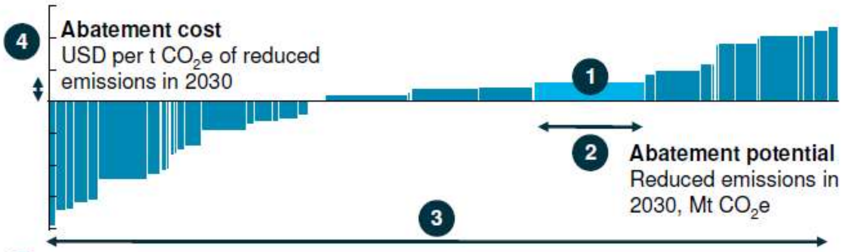
The development of opportunity cost curves requires a solid regional database on the economics of land use types, the historical land use changes (land use matrix) and data on the long-term average carbon stocks for each land use. For the estimation of national opportunity cost curves specified to regional economic and carbon stock conditions the current national forest inventory, and reference emissions level development are crucial components to develop a solid national opportunity cost curve, complemented by regional data of land use economics.

National opportunity cost curves would serve as a decision-making tool to prioritize the most cost-effective REDD+ activities in Tanzania and identify strategies and sustainable business models to address the drivers of deforestation. This relates to the development of strategies of a more productive intensified climate-smart agriculture, more sustainable charcoal and fuel wood production production systems and the development of sustainable forest management practices that will generate additional revenues streams apart from potential carbon payments. Potential REDD+ finance for GHG emission reductions and carbon removals must be regarded as a lever to shift from unsustainable to more sustainable practice that reduce and avoid deforestation and forest degradation.

After the identification of sustainable business models a national marginal abatement cost curve could be designed that provided information on the annual potential of GHG emission abatements in a given year and the cost per ton abated in a given year (Figure 15). The abatement costs of each initiative is defined as the incremental costs of a low-emission path compared with the required cost or benefits of the conventional alternative underlying the business as usual scenario. The costs are measured in US$/t$CO_2$ for a given year in the future.

Figure 15: Example of a national marginal abatement cost curve

The Abatement Cost Curve allows us to **view and compare all the available options for reducing emissions** along two key dimensions at once: How much can each option contribute to emissions abatement, and at what cost does it do so?



1. Each option for reducing emissions is represented by a bar on the cost curve.
2. The width of each bar shows the abatement potential – the tonnes of annual emissions that would be reduced in 2030 if we implemented this option fully.
3. The sum of the width of all bars shows the sum of the abatement potential of all initiatives – in reality the aggregated abatement potential will be lower than the sum of each initiatives as it might not be feasible to implement some initiatives at the same time
4. The height of each bar shows the abatement cost – the cost of implementing this option fully in terms of dollars per ton of reduced annual emissions.

The bars on the right represent costly options, while the bars that face downward represent options that actually have negative cost: they save money as well as emissions.

Source: Ethiopia's Climate-Resilient Green Economy, (2012)

8. Conclusions

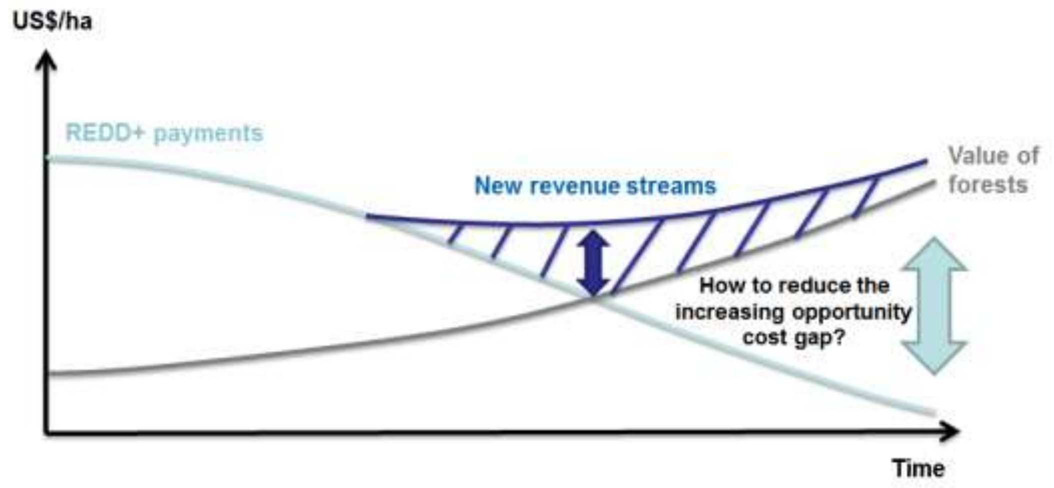
8.1 Overall conclusion

The REDD+ cost curve is a useful and flexible tool well suited to the Tanzanian context where REDD+ projects continue to be designed and real data continues to become available. The cost curves allow project developers to determine the carbon price that would be required to meet the opportunity cost of selected land use practices, and the total amount of emission reduction that could be obtained for each land-use type. The tool allows for forecasting the impact of policy changes, such as improved forest law enforcement or agricultural subsidy programs, on the total REDD+ costs within any given project. The tool also allows for national cost curves to be generated from individual project data inputs over time.

The anticipated revenues from REDD+ cannot be expected to cover all REDD+ costs for projects aiming to address deforestation drivers such as agricultural expansion or charcoal production. As such, REDD+ initiatives need to be closely integrated with other sectoral investment plans (such as agriculture and energy) to ensure harmonization of plans, and to offset implementation costs

Current REDD-readiness planning in Tanzania is being undertaken, in anticipation of a future REDD+ compliance market. While REDD+ revenues may be significant initially, they are certain to decline as deforestation rates drop. It will be important to channel a significant share of revenues into raising the value and productivity of both forests and surrounding landscapes to provide alternative (and sustainable) revenue streams in the future. This is illustrated in the figure below.

Figure 16: Revenue streams and increasing opportunity costs



8.2 Technical conclusions

8.2.1 Data quality

Work on the study revealed that complete data sets to estimate costs of REDD+ in Tanzania are limited. At project level, input information to calculate opportunity costs are only available for a limited number of drivers of deforestation and degradation.

Most critical data gap is the lack of land use change matrices at project level, which are crucial to calculate present and anticipated future opportunity costs.

Implementation costs are only considered at project level for three to five years, but not over the full lifetime of the projects (30 years).

At national level most critical data gaps were identified regarding the outstanding national forest inventory data (to be expected in 2013) and related land use change detection information. Further, the pending decision on a forest definition for REDD+ is causing inconsistency about the forest area national institutional costs should be allocated to.

Institutional costs related to enforcement of REDD+ framework and PFM activities vary greatly at district level due to the variable institutional capacities on the ground. Thus, institutional costs allocated to REDD+ projects vary between projects.

8.2.2 Opportunity Cost

Considering the restrictions related to data quality and availability, the elaborated opportunity cost curve provides information on the quantity of potential emission reductions and their cost (per tonne of CO_2). The opportunity cost curve represents data from three pilot project sites, in total covering an area of 358,000 hectares of forest in western, central and southern Tanzania.

8.2.3 Institutional Costs

Districts receiving funds from central government to support the introduction of PFM perform at very different levels of effectiveness and efficiency. For those districts that were able to complete the PFM process in more than 75% of the sites supported, the cost / hectare was US$22.9. When the same process was implemented by NGOs, the costs varied from US$ 10.6 – 34.3 / hectare, with an average of US$22.5 / hectare. These figures suggest that there are no significant differences in costs of a PFM process facilitated by district authorities when compared to a similar process facilitated by an NGO.

When the implementation costs of introducing PFM are combined with additional costs of supporting a broader process of rural development, through for example, sustainable agricultural intensification and reducing demands for charcoal the cost per hectare rises significantly, up to an average cost of US$ 84/hectare. This combination of PFM plus integrated rural development is likely to be a common characteristic of REDD+ projects in Tanzania, so costs in this area are likely to be typical.

Costs per village provide a much more uniform cost-estimate than costs per hectare for supporting the introduction of PFM, although there are significant differences between NGO costs and those of government. This is perhaps unsurprising as many of the costs tend to be directed at the village government, and are less determined by area. The average cost per village of supporting PFM establishment is $3,298 when implemented by local governments compared to US$20,866 / village when implemented by NGOs.

The costs of effective forest management, as estimated by TFS is US$8.3/hectare, but current budget constraints mean that current expenditure is around US$ 2.3/hectare. This compares with US$ 7.7/hectare, being the actual revenue spent by TANAPA to manage forest areas under their jurisdiction. The estimate of recurrent forest management costs by communities for areas under PFM is $2.3/hectare – just over a quarter of the estimated costs of effective management defined by TFS.

8.2.4 Implementation costs

In addition to the opportunity costs, all REDD+ projects will face implementation costs and transaction costs. As presented above, institutional costs will arise that are only partly paid by the project developers, and will have to be included in the national budgets of the REDD+ readiness and implementation plans. Of these three costs, implementation costs are by far the biggest portion. The results show a high variation of implementation costs between pilot projects.

Care must be taken when comparing these costs and drawing conclusions regarding the relative costs of different NGO-implemented projects. The JGI and TFCG pilot projects address a range of deforestation drivers (including supporting agricultural development to address slash and burn), whereas the MCDI project is effectively supporting the introduction of sustainable forest management through community based forest management, and is not addressing other (more costly) drivers such as agriculture.

8.2.5 Total REDD+ Costs / tCO_2

The findings indicate significant differences between projects in terms of the total costs of avoiding carbon emissions. The MCDI project has the lowest total cost (at US$ 4.9 /tCO2 while the JGI project has the highest total REDD+ costs at US$ 13.8/tCO2.

Care must be taken in drawing conclusions about efficiency levels of different pilot projects – the MCDI project experiences no opportunity costs (due to lack of deforestation pressure) and does not face heavy implementation costs to address these drivers. The JGI project appears to be more expensive, due to both significant opportunity as well as implementation costs faced in this zone.

The figures above might be brought down to a more realistic perspective if:

- other sources of income are taken into consideration (such as anticipated incomes to farmers from improvements in agricultural production, or income from forest harvesting)
- some of the costs, such as those relating to agricultural improvements and addressing charcoal production and sale were included under other budgets (such as those of the Ministry of Agriculture, or Ministry of Energy)

9. References

Antinori, C. and J. Sathaye (2007): Assessing transaction costs of project-based greenhouse gas emissions trading. Lawrence Berkeley National Laboratory. Berkeley, C.A., USA.

Boucher, D. (2008): What REDD can do: The Economics and Development of Reducing Emissions from Deforestation and Forest Degradation. Draft for external review (June). Tropical Forest and Climate Initiative – Union of Concerned Scientists. Washington D.C., USA.

Burgess. N and Kilihama, F. (2004): Is enough being invested in Tanzania's Eastern Arc Mountains? Arc Journal. Issue 17. Tanzania Forest Conservation Group. Tanzania

Camco Advisory Services , (2009). Feasibility Study to Assess the Potential of the Angai Village Land Forest Reserve to become a Community REDD Project. Report presented to the Clinton Foundation – Clinton Climate Initiative.

Eliasch, J. (2008): The Eliasch Review – Climate Change: Financing Global Forests. UK Office of Climate Change. Available online at: http://www.occ.gov.uk/activities/eliasch.htm.

Ethiopia's Climate-Resilient Green Economy – Green Economy Strategy, (2012). FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA.

FAO (2010): Carbon Finance possibilities for agriculture, forestry and other land use projects in a smallholder context. FAO, Rome

Fisher, B. et al (2011): Implementation and opportunity costs of reducing deforestation and forest degradation in Tanzania. Nature Climate Change, published online: 29 May 2011

Forest Trends (2011): REDD Guidance. Technical Project Design. Washington D.C

Grieg-Gran, M. (2008): The cost of avoiding deforestation: Update of the report prepared for the Stern Review of the Economics of Climate Change. Paper commissioned by the

Office of Climate Change as background work to its report Climate Change: Financing Global Forests (The Eliasch Review). IIED, London, UK.

IUCN (2009): The Financial Costs of REDD: Evidence from Brazil and Indonesia

Kindermann, G., M. Obersteiner, B. Sohngen, J. Sathaye, K. Andrakso, E. Rametsteiner, B. Schlamadinger, S. Wunder and R. Beach (2008): Global cost estimates for reducing carbon emissions through avoided deforestation' in Proceedings of the National Academy of Science of the Unites States of America. Available online at: http://www.pnas.org/content/105/30/10302.full

MNRT (2003): Resource Economic Analysis of Catchment Forest Reserves in Tanzania. Ministry of Natural Resources and Tourism, Dar es Salaam

Nepstad, D., B. Soares-Filho, F. Merry, P. Moutinho, H. Oliveira-Rodriguez, M. Bowman, S. Schwartzman, O. Almeida and S. Rivero (2007): The costs and benefits of reducing carbon emissions from deforestation and forest degradation in the Brazilian Amazon. WHRC-IPAM-UFMG.

World Bank (2011): Estimating the Opportunity Costs of REDD+: A training manual. Version 1.3. The World Bank, Washington. Available at: http://wbi.worldbank.org/wbi/Data/wbi/wbicms/files/drupal-acquia/wbi/OppCostsREDD+manual.pdf

Zahabu, E. (2011) Ground Forest Carbon Assessment of the Masito Ugalla Ecosystem Pilot Area. Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture. Prepared for the The Jane Goodall Institute

Annex 1 – Input Parameters

Project key data

In the project key data input sheet the user has to classify the existing land use types in the project and estimate the area covered by the project and select the project lifetime (as shown in table below). Thereby, the user may choose among land use types (see Table 14: Data entry sheet for land use type areas (ha)) for which a separate 1-ha based model sheet is constructed (see Land use economics section). The Excel-tool is constructed in a manner that allows the user to input data only in yellow cells, while the remaining fields are protected and not changeable.

Table 14: Data entry sheet for land use type areas (ha)

Land use types of the project area (ha):	Historical land use on project area	At project start
Natural forest	85.200	71.037
Unsustainable timber extraction		3000
Sustainable timber extraction		
Unsustainable fuelwood collection		4000
Unsustainable charcoal production		
Sustainable fuelwood production		
Sustainable charcoal production		
Agriculture (Permanent cropping systems)		
Agriculture (Shifting cultivation)		5163
Improved agriculture (Permanent cropping systems)		
Improved land use (Shifting cultivation)		
Commercial agriculture (Oil palm)		
Commercial agriculture (Jatropha)		
Commercial agriculture (Sugar Cane)		
Commercial agriculture (Maize farming)		
Pasture (Cattle grazing)		2000
Pasture (Sheep/goats)		
Total	**85.200**	**85.200**

For the purpose of a REDD+ opportunity cost analysis, a value of a time-averaged carbon stock must be estimated for each identified land use system (World Bank, 2011). A typical carbon stock value integrates the gains and losses over a life-cycle of a land use. This single value is used for carbon accounting purposes and is compared with an economic indicator in form of Net Present Value (NPV in US$/ha). The table below shows the data entry masks in the REDD+ cost elements tool.

Table 15: Data entry sheet for land use type carbon stocks

Land use types	Aboveground carbon (tCO2/ha)	Belowground carbon (tCO2/ha)	Soil carbon (tCO2/ha)
Natural forest	67,2	13,4	
Unsustainable timber extraction	23,8	6,4	
Sustainable timber extraction			
Unsustainable fuelwood collection	23,8	6,4	
Unsustainable charcoal production			
Sustainable fuelwood production			
Sustainable charcoal production			
Agriculture (Permanent cropping systems)			
Agriculture (Shifting cultivation)	20,0	5,0	
Improved agriculture (Permanent cropping systems)			
Improved land use (Shifting cultivation)			
Commercial agriculture (Oil palm)			
Commercial agriculture (Jatropha)			
Commercial agriculture (Sugar Cane)			
Commercial agriculture (Maize farming)			
Pasture (Cattle grazing)	17,5	4,7	
Pasture (Sheep/goats)			

Land use economics

Following the step-wise approach, each identified land use type requires an economic indicator in form of a NPV (US$/ha) as a comparable economic parameter for different land use types.

Data input sheets have been developed for each land use that requires the user analyzing the existing land use costs and benefits on a per ha basis in order to realistically reflect the NPV of each land use. Also natural forest receives an NPV e.g. for extensive fuel wood collection, or other non-timber forest products.

Table 16: Natural forest data entry sheet

Natural forest

Annual costs	Quantity	Unit	Price per Unit	Quantity	Unit	Source
Annual labour costs	0	days/ha/yr	0	0	US$	
Annual labour costs NTFP collection	30	days/ha/yr	3	90	US$	
Annual cost small-scale timber extraction						
Harvesting	0	US$/m³		0	US$	
Timber transportation	0	US$/m³		0	US$	
Milling	0	US$/m³		0	US$	
Total costs				**90**	**US$**	

Yields and Prices	Quantity	Unit	Price per Unit	Quantity	Unit	Source
Annual fuel wood collection	0	m³	0	0	US$	
Annual NTFP collection	15	kg/ha	12,5	187,5	US$	
Annual income from water		US$/ha		0	US$	
annual income from biodiversity		US$/ha		0	US$	
Annual small-holder timber extraction revenues						
Annual timber extraction volume	0	m³/ha/yr				
Waste	0%					
Quantity sold	0,0	m³/ha/yr				
Price	0	US$/m³		0	US$	
Total revenues				**188**	**US$**	

As an example for other land use types, agricultural land use is presented below. Initially the user has to select between permanent cropping systems or shifting cultivation and afterwards the most common crops being grown on farms, e.g. maize, beans, rice etc. Thereby the user must estimate a percentage of each crop in the typical agricultural system that reflects the project conditions (Table 17: Data entry sheet for agriculture mix):

Table 17: Data entry sheet for agriculture mix

Land use distribution for Agriculture (permanent cropping systems)	% of total af land use
Activity 1: Maize farming	0%
Activity 2: Beans	0%
Activity 3: Cassava	0%
Activity 4: Groundnuts	0%
Activity 5: Rice	0%
Activity 6: Sweet potato	0%
Activity 7: Cashcrops (oil palm)	0%
Activity 8: XXX	0%
Total	**0%**

Afterwards the economics of each selected crop have to be estimated, using the following data sheets. All known inputs, costs, yields and revenues can be entered into the model; estimates can also be used if exact information is missing.

Table 18: Data entry sheets for agricultural land use

Activity 1: Maize farming

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	Source:
Seed	10	kg	2.5	25	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	76	days	3	228	US$	
Total cost establishment				**253.0**		

Inputs at management (from year 1 onwards)	Quantity	Unit	Price per unit	Costs	Unit	Source:
Seed	10	kg	2.5	25	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	46	days	3	138	US$	
Total cost management				**163**	**US$**	

Income	Quantity	Unit	Price per unit	Revenues	Unit	Source:
Yields t/ha/yr	2500	kg/ha/yr	0.18	450	US$	
Yield start after establishment	1	Year				
Total income				**450**	US$	

The tool automatically generates an NPV for each land use type (over 10, 20 and 30 years period) separately for a maximum period of 30 years (Table 19: Economic output table and NPV for 1 ha maize farming (US$)) and based on the selected mix (%) of the identified crops a mixed cropping system NPV is generated (Table 20: Economic output table and NPV for mixed cropping systems (US$) below).

Table 19: Economic output table and NPV for 1 ha maize farming (US$)

Year	0	1	2	3	4
Activity 1: Maize farming					
Annual production costs	253	163	163	163	163
Annual revenues	450	450	450	450	450
Annual cashflows	197	287	287	287	287
Cumulative cashflows	197	484	771	1058	1345
NPV (10 years)	**1.782 €**				
NPV (20 years)	**2.400 €**				
NPV (30 years)	**2.639 €**				

Table 20: Economic output table and NPV for mixed cropping systems (US$)

Agriculture permanent cropping system					
Annual production costs	401,1	231,3	231,3	231,3	231,3
Annual revenues	635,0	635,0	635,0	635,0	635,0
Annual cashflows	233,9	403,7	403,7	403,7	403,7
Cumulative cashflows	233,9	637,6	1041,3	1445,1	1848,8
NPV (10 years)	**2.468 €**				
NPV (20 years)	**3.337 €**				
NPV (30 year)	**3.672 €**				

Having determined the 1-ha economics of each identified land use system in the project area, the next step leads to the analysis of the opportunity costs.

Opportunity costs analysis

The last remaining component of the opportunity costs analysis is the development of a land use change matrix. This relates to the identification of the land use change patterns based on an analysis of the drivers of deforestation. Table 21: Land use change matrix (ha) below presents the estimated land use change matrix for a project case. The vertical column indicates the year of the initial land cover. The change to another land use is shown on the horizontal row (in green font). The diagonal of the table indicates unchanged land area between two time series (in orange font). The figures in green font indicate the conversion of natural forest at an historical point in time to different other land use types, identified as the drivers of deforestation at the current point of time (e.g. at project start).

Table 21: Land use change matrix (ha)

Initial (change from initial land cover) / Final (change to final stage/latest land cover classification) (ha)	Natural forest	Unsustain able timber extraction	Unsustainable fuel wood collection)	Agriculture (Shifting cultivation)	Pasture (Cattle grazing)	Total
Natural forest	71,037	3,000	4,000	5,163	2,000	**85,200**
Unsustainable timber extraction)		0				**0**
Unsustainable fuel wood collection			0			**0**
Agriculture (Shifting cultivation)				0		**0**
Pasture (Cattle grazing)					0	**0**
Total	**71,037**	**3,000**	**4,000**	**5,163**	**2,000**	**85,200**

Based on the aforementioned components that are entered into the REDD+ cost elements tool, the users will receive an analysis of the opportunity costs. The tool is designed in a manner that summarizes all required data input values for ABACUS in one sheet that can be copied and pasted in ABACUS[5] data entry sheets. The required data includes input values on the project area and land use classification data, carbon stock data, land use change matrix and the calculated NPV.

Based on this data the REDD+ cost element tool produces a GHG emissions matrix using data from the land use change matrix and carbon stock of each land use and an opportunity cost matrix (see table below) based on the NPVs and carbon stock data. Using these outputs the user may construct graphs that visualize the generated outputs.

[5] For the use of ABACUS, see the explanations in the manual available at: http://www.worldagroforestry.org/sea/abacus

Table 22: Opportunity costs matrix

Opportuntiy costs US$/tCO2				
Initial/Final (ha)	Natural forest	Unsustainable timber extraction	Sustainable timber extraction	Unsustainable fuelwood collection
Natural forest		15,1	0,0	-7,8
Unsustainable timber extraction	0,0		0,0	0,0
Sustainable timber extraction	0,0	0,0		0,0
Unsustainable fuelwood collection	0,0	0,0	0,0	
Unsustainable charcoal production	0,0	0,0	0,0	0,0
Sustainable fuelwood production	0,0	0,0	0,0	0,0
Sustainable charcoal production	0,0	0,0	0,0	0,0
Agriculture (Permanent cropping systems)	0,0	0,0	0,0	0,0
Agriculture (Shifting cultivation)	0,0	0,0	0,0	0,0
Improved agriculture (Permanent cropping systems)	0,0	0,0	0,0	0,0
Improved land use (Shifting cultivation)	0,0	0,0	0,0	0,0
Commercial agriculture (Oil palm)	0,0	0,0	0,0	0,0
Commercial agriculture (Jatropha)	0,0	0,0	0,0	0,0
Commercial agriculture (Sugar Cane)	0,0	0,0	0,0	0,0
Commercial agriculture (Maize farming)	0,0	0,0	0,0	0,0
Pasture (Cattle grazing)	0,0	0,0	0,0	0,0
Pasture (Sheep/goats)	0,0	0,0	0,0	0,0

Implementation costs

In the implementation sheet the user is given a lot of flexibility to compile and enter all relevant costs that will arise over the project lifetime. Here arrays of different cost categories are given that refer to activities to address the drivers of deforestation. However, the user may alter the different cost categories based on requirements and cost structures. An example of the sheet is given in table below:

Table 23: Data entry sheet for implementation costs (US$)

Implementation cost positions			
Years	0	1	2
A: Project planning and design total (US$)			
Analysis of drivers of deforestation			
Prepraration of action plans			
Consultations and stakeholder engagement			
Capacity needs assessments			
Development of monitoring capacity			
Land use planning and zoning			
Stakeholder and policy level awareness raising on REDD+			
Training of project implementation groups			
Design of a benefit sharing mechanisms			
SFM/PFM planning			
Sub-total	0	0	0
B: Project implementation costs total			
Technical staff costs		225.193	231.203
Administrative/management staff costs		68.065	71.468
Other staff costs (allowances, benefits insurance etc)			
Project administration/Office running costs		17.300	18.165
Investment costs (Equipment, furniture/Remote sensing data, licenses)		251.800	27.550
Transport and communication		32.400	34.020
Benefit sharing mechanisms and monitoring best practice (social environmental surveys included)		21.510	113.500
SFM/PFM implementation/expansion /Combating leakage/forest management/CBO/CFM formation and management, capacity building		211.448	195.727
Project monitoring and evaluation costs		89.880	132.909
Biodiversity surveys/monitoring			
Sub-total	0	917.596	824.542

Transaction costs

The transaction cost sheet is constructed in a similar manner to the implementation costs sheet, which flexibly allows the user to estimate transaction costs. Initially, several key assumptions fields are provided that can be modified as shown in the table below:

Table 24: Estimation of transaction cost categories

Cost type	Value	Unit
Feasibility study in year 0	15.000	US$
PDD development		
Carbon baseline study in year 1	20.000	US$
Methodology development/revision (year 1)	10.000	US$
Design and testing of monitoring plan	30.000	US$
Remote Sensing costs	10.000	US$
PDD preparation (in year 1)	40.000	US$
Sub-total	**110.000**	**US$**
Monitoring, Reporting and Verification		
Validation costs in year 2	20.000	US$
Verification costs every 5th year	20.000	US$
Monitoring, reporting costs every 5 th year	50.000	US$
Registration fee registry / tCO2	0,05	US$
Certification fee carbon standard /tCO2	0,03	US$
Legal/Contractual costs in year 1	0	US$
Government sales taxes	5%	

Based on this key input data, Excel generates an automatic costing of transaction costs over the project lifetime. However, transaction cost may differ significantly among projects and countries. Thus the formulas within the transaction costs may be changed allowing for a higher flexibility. In addition, the user may add additional cost categories to the data sheet.

Table 25: Data entry sheet for transaction costs (US$)

Years	0	1	2	3	4
Feasibility study in year 0	15.000				
PDD development		110.000			
Validation and verification costs			70.000		
Carbon related mapping, remote sensing (GIS) monitoring, reporting costs and training					
Registration costs (Registry)			5.500	2.750	2.750
Certification fees (Standards)			3.300	1.650	1.650
Marketing					
Legal (consultancy) costs					
Government sales taxes			13.750	13.750	13.750
Total transaction costs	**15.000**	**110.000**	**120.050**	**31.900**	**31.900**

Institutional cost

Similar to the implementation and transaction cost estimates, the institutional data input sheet allows estimating institutional cost on the national and district level. Also here the cost categories are pre-defined, but can be changed based on country-specific conditions in the yellow fields (see table below). For the Tanzanian case we used the budgets of the REDD-Readiness and REDD+ implementation process, equivalent to US$ 2.1 million between 2010 and 2013 broken down to the national forest area, resulting in an US$ 0.01/ha/yr.This value has then been up-scaled to the project area estimating the institutional costs and complemented by the project specific budgets that assigned a portion to district level institutional capacity building and knowledge dissemination.

However, we have used the values in our calculation tool to address the issue of institutional costs in general. Still, the users of the tool are free to change the costs according to their knowledge and perception.

Same for institutional costs at district level: Here in districts with strong enforcement by the state the projects could apply the figures explained in chapter 0, while in districts with weak enforcement, the projects themselves have to implement such activities. Thus, they should be considered as implementation costs.

Table 26: Estimation of institutional costs categories (US$)

Institutional costs					
Years	**0**	**1**	**2**	**3**	**4**
National level					
REDD Readiness and Implementation	2.982	2.982	2.982	2.982	2.982
Law enforcement costs					
Capacity building of implementation structures and organs (Training policies related to carbon)					
Development and training of Mapping and MRV capacity					
Knowledge dissemination					
Sub-total cost	**2.982**	**2.982**	**2.982**	**2.982**	**2.982**
District level					
Policy anaylsis / scheme design / forest management rights					
Capacity building on REDD governance					
Capacity building of implementation structures and organs (business skills/trade, REDD project development/management skills)					
Development and training of forest management/MRV capacity (not carbon related)					
Administration of national park					
Knowledge dissemination					
Sub-total cost	**0**	**0**	**0**	**0**	**0**
Total institutional costs	**2.982**	**2.982**	**2.982**	**2.982**	**2.982**

Project summary

The final "project cost summary" sheet summarizes the total costs of a REDD+ project on a project scale, and per hectare. It calculates the required price per saved tCO_2, assuming that no other revenue streams would be generated (Table 27: Projection of avoided deforestation area and GHG emission reductions).

The user has to enter the expected GHG emissions reductions or carbon benefits and the total area of avoided deforestation over the project lifetime in order calculate the total costs for each avoided tCO_2 emission.

Table 27: Projection of avoided deforestation area and GHG emission reductions

Estimation of carbon benefits and avoidance of deforestation					
Years	1	2	3	4	5
Annual net area avoding from conversion (ha)	667	667	667	667	667
Annual net emission reduction (tCO2)	55.000	55.000	55.000	55.000	55.000

Table 28: Project cost summary (US$)

Applied currency	US$	
Project lifetime	30	Years

Cost category	Total project costs	Total costs per ha	Costs per saved tCO2
Project implementation costs	20.165.127	236,7	12,2
Transaction costs	2.414.419	28,3	1,5
Institutional costs	158.903	1,9	0,1
Total costs	**22.738.449**	**266,9**	**13,8**

While this tool is constructed to estimate the REDD+ cost element, the next step would be to develop marginal abatement costs curves. This would require estimates of potential revenues from the implementation of a REDD+ project and compare it to total costs.

Annex 2 – Jane Goodall Kigoma Project

Summary Report

Modeling approach and key assumptions

In the framework of the assignment *Estimating Cost elements of REDD+ in Tanzania* funded by the UN-REDD Programme, a methodology was developed to estimate opportunity costs, implementation costs, institutional costs and transaction costs of REDD+ projects, specified to Tanzanian circumstances. The Excel-based model is designed in a manner allowing to use the Excel data as input data for the REDD ABACUS software (Beta Version: 1.1.1 beta1 (13 Dec 2011[6])) that automatically generates opportunity cost curves.

The Excel-based model is designed in an iterative manner and requires the user to initially identify the persistent land use types at a historical point in time and at the project start and undertake a land use classification and assessment of the carbon stock data for the identified land use types.

Following this step, 1-ha based land use economics are calculated to generate a NPV value for all identified land use types. In the opportunity cost analysis stage a land use change matrix has to be developed that reflect the historical land use change patterns and to which land use types forest have been converted. If there is no historical conversion of forest to other land uses opportunity costs do not appear and no opportunity cost curves can be generated.

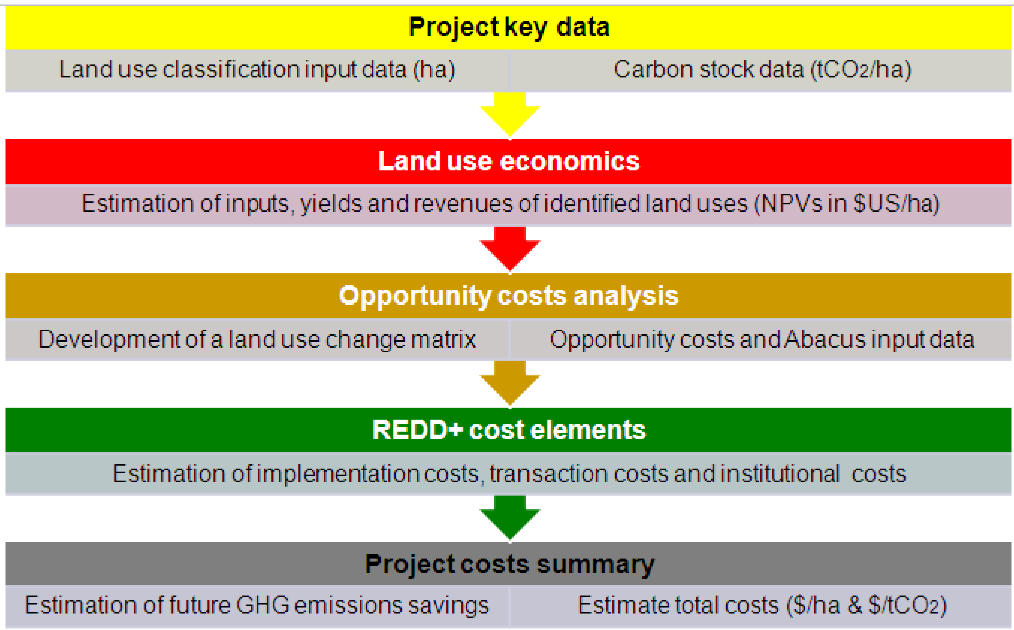
Main outputs of processing the 1-ha economic models are net present values as explained in the main report and land use related carbon stock changes. Based on this output all required input data for REDD ABACUS is generated and opportunity cost curves can be processed with ABACUS.

In the subsequent phase other REDD+ cost elements, namely institutional, implementation and transaction costs are estimated. While the transaction costs and implementation costs are derived from the project documents, institutional costs are calculated from a national average.

[6] http://www.worldagroforestry.org/sea/abacus

The model allows estimating all four REDD+ cost elements. Hence, indicating REDD+ costs for the envisaged emission savings by the project.

Figure 17: Methodology to estimate REDD+ cost elements



Project key area and carbon stock assumptions

For the Jane Goodall Kigoma project model we used input data from the project documents provided to the consultants and a project specific workshop in Dar es Salaam on the 14th February 2012.

With regards to the drivers of deforestation, we used unsustainable timber extraction, unsustainable fuelwood collection, shifting cultivation and cattle grazing as the most important driver as shown in Table 29: Project area assumptions.

For the Jane Goodall Kigoma project the following assumptions were made based on the analysis of the project documents and inputs from Jane Goodall project staff.

Table 29: Project area assumptions		
Land use types of the project area (ha):	Historical land use on project area (ha)	At project start (ha)
Natural forest	85,200	71,037
Unsustainable timber extraction	0	3,000
Unsustainable fuelwood collection	0	4,000
Agriculture (Shifting cultivation)	0	5,163
Pasture (cattle)	0	2,000
Total	85,200	85,200

Carbon stock data of land use types

For the carbon stock data the long-term average carbon stocks shall be used. Based on provided data and our own estimates, the following carbon information was generated and used in our further calculations:

Table 30: Carbon stock assumptions		
Land use types	**Carbon stocks (ABG, BGB) (tCO_2/ha)**	**Carbon stocks (ABG, BGB) (tC/ha)**
Natural forest	80.6	22
Unsustainable timber extraction	30.2	8.2
Unsustainable fuelwood collection	30.2	8.2
Agriculture (Shifting cultivation)	15.3	4.2
Pasture (cattle)	22.2	6.1

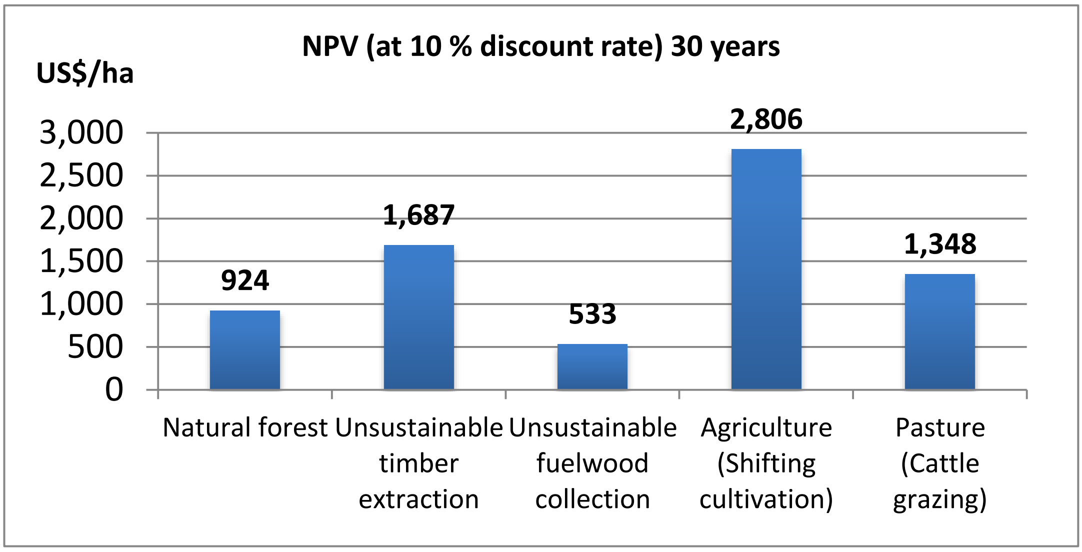
Note: The long-term average is based on the average carbon stock as identified in the Ground Forest Carbon assessment of the Masito Ugalla Ecosystem Pilot area (Zahabu, 2011) and Fisher et al, 2011.

1-ha models for existing land use types

For the establishment of opportunity costs curves each identified land use type requires the establishment of a Net Present Value (NPV), an economic performance indicator that shows the profitability of a land use in US$/ha. For the NPV calculation we used a discount rate of 10 % and discounted the annual cost and revenues over a period of 30 years, equivalent to the project lifetime.

Figure 18 present the NPVs for the identified land uses. All key assumptions made in these 1-ha models are detailed in Annex 1.

Figure 18: NPVs for the Jane Goodall Kigoma project



Land use change matrix

The land use change matrix is a key input for the opportunity cost analysis spreadsheet which is also used as an input table for ABACUS. It provides information about the land use change dynamics in the project area. In addition to providing data needed for the opportunity cost analysis, the land use change matrix can be used to assess the driving forces of deforestation and land use trajectories over time. The land use change matrix is normally based on the historical remote sensing analysis that compares land uses at two different points in time, e.g. 2001 and 2011.

Table 31: Land use change matrix for project (2001-2011) (ha) presents the estimated land use change matrix for the project case. The vertical column indicates the year of the initial land cover. The change to another land use is shown on the horizontal row. The diagonal of the table indicates unchanged land area units between two time series (in orange font). The figures in green font indicate the conversion of natural forest at an historical point in time to different other land use types, identified as the drivers of deforestation at the current point of time (e.g. at project start).

The total value at the end of the first row is the area in natural forest at the historical point of time (85,200 ha). The total value at the bottom of the second column is the total area in natural forest at project start (71,037 ha). Therefore the study area lost 14,163 ha of forest between the two points of time.

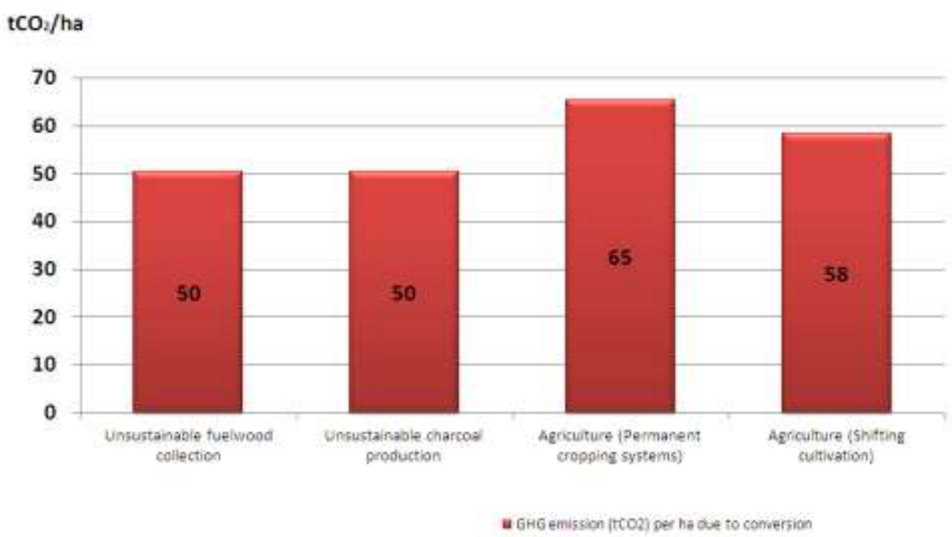
Table 31: Land use change matrix for project (2001-2011) (ha)

Initial (change from initial land cover) / Final (change to final stage/latest land cover classification) (ha)	Natural forest	Unsustainable timber extraction	Unsustainable fuel wood collection)	Agriculture (Shifting cultivation)	Pasture (Cattle grazing)	Total
Natural forest	71,037	3,000	4,000	5,163	2,000	85,200
Unsustainable timber extraction)		0				0
Unsustainable fuel wood collection			0			0
Agriculture (Shifting cultivation)				0		0
Pasture (Cattle grazing)					0	0
Total	71,037	3,000	4,000	5,163	2,000	85,200

Opportunity costs

The opportunity costs were calculated based on the following carbon stock losses (tCO_2/ha) from the conversion of natural forest to the respective land use types.

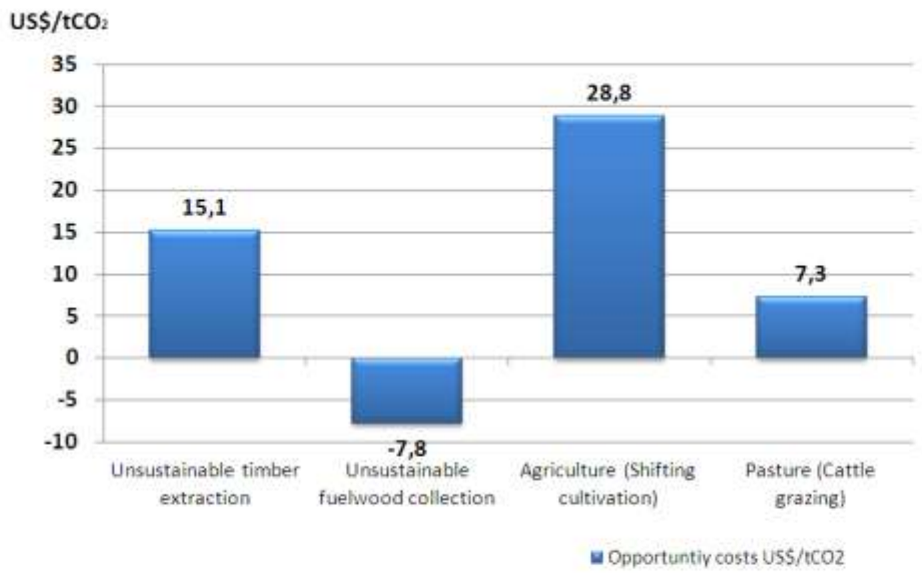
Figure 19: GHG emissions (tCO2/ha) from conversion of natural forest to other land use types in the Jane Goodall Kigoma project area



Using the NPV – and the respective carbon stock data, for each land use – the following opportunity costs (US$/$tCO_2$) were calculated by dividing the opportunity cost NPV (Figure 18) for the land use change by the related carbon stock change (Table 30) per ha.

In the Jane Goodall Kigoma project case the opportunity costs would range between US$ 28.8/tCO_2 for agriculture (shifting cultivation) and US$ -7.8/tCO_2 for unsustainable fuel wood collection. Thus, avoiding land use conversion from natural forest to fuel wood collection would result in net GHG benefits at negative costs because the NPV for this land use is lower than that of natural forests. For shifting agriculture, the NPV is higher than that of natural forest. Thus, opportunity costs are positive. The costs indicate which monetary value will forego the user when not converting the forest.

Figure 20: Opportunity costs (US$/tCO2) from conversion of natural forest to other land use types in the Jane Goodall Kigoma project

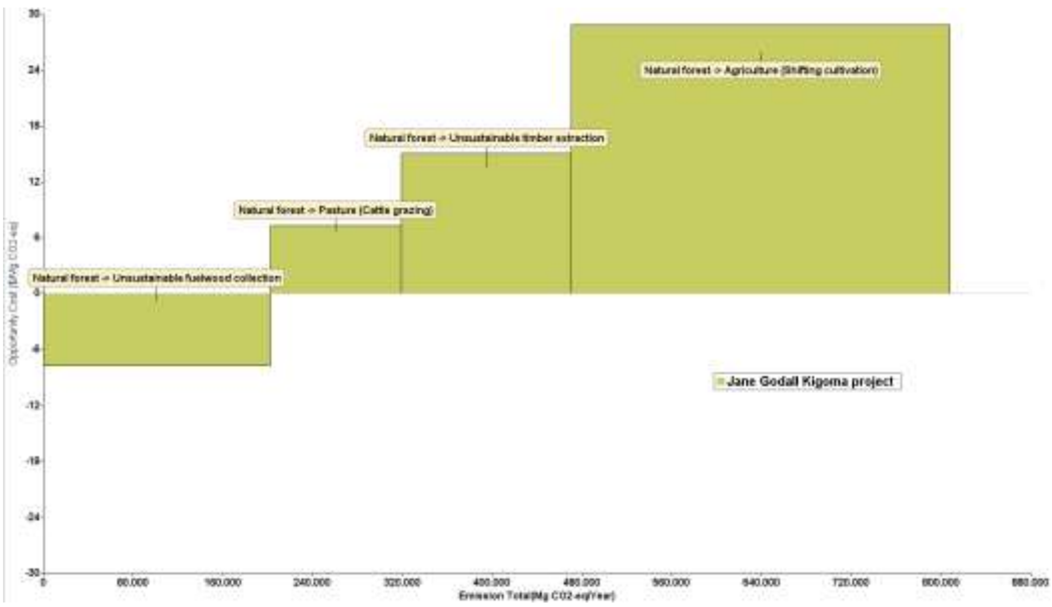


The described data – i.e. NPV and land use change matrix based carbon stock changes – constitute the key input data for the ABACUS software to generate the project's opportunity cost curves.

An opportunity cost curve compares the quantity of potential emission reductions with their opportunity costs. The vertical y-axis represents the opportunity cost of the emissions reduction option (in US$ per tCO_2), while the horizontal axis depicts the corresponding quantity of reduction (in million tCO_2) at the respective price.

For the described land use change scenario (land use matrix, Table 21: Land use change matrix (ha)) emissions of about 0.81 million tCO_2 would occur over a period of 10 years.

Figure 21: Opportunity cost curve Jane Goodall Kigoma project



Note: The GHG emissions in the cost curve occurred over a period of the last 10 years, as based on historical land use change indicated in the land use change matrix.

Building the REDD+ project case

The opportunity cost curves are based on historical data and land use dynamics. In order to estimate the complete REDD+ project cost elements, implementation costs, transaction costs and institutional costs need to be estimated. In our calculation we assume that opportunity costs will be compensated by the implementation activities, thus opportunity costs are not added up to total costs. For detailed explanation, refer to the main report.

Implementation costs are directly associated with actions to reduce deforestation and forest degradation. Examples include the costs of guarding a forest to prevent unsustainable timber extraction, replanting trees in degraded or logged forests, or intensifying agriculture or cattle ranching. Implementation may also comprise the training and capacity-building activities at the project level that are necessary to make the REDD+ programs happen.

For the implementation and transaction costs we used the annual project budget of the Jane Goodall Kigoma project and assigned the respective cost the implementation and transaction cost categories.

Transactions costs are incurred throughout the process: certifying the project according to a carbon standard, transaction negotiation, monitoring, reporting, and verifying GHG emission reductions. Transaction costs are incurred by the implementers of a REDD+ program and third parties such as verifiers, certifiers, and lawyers.

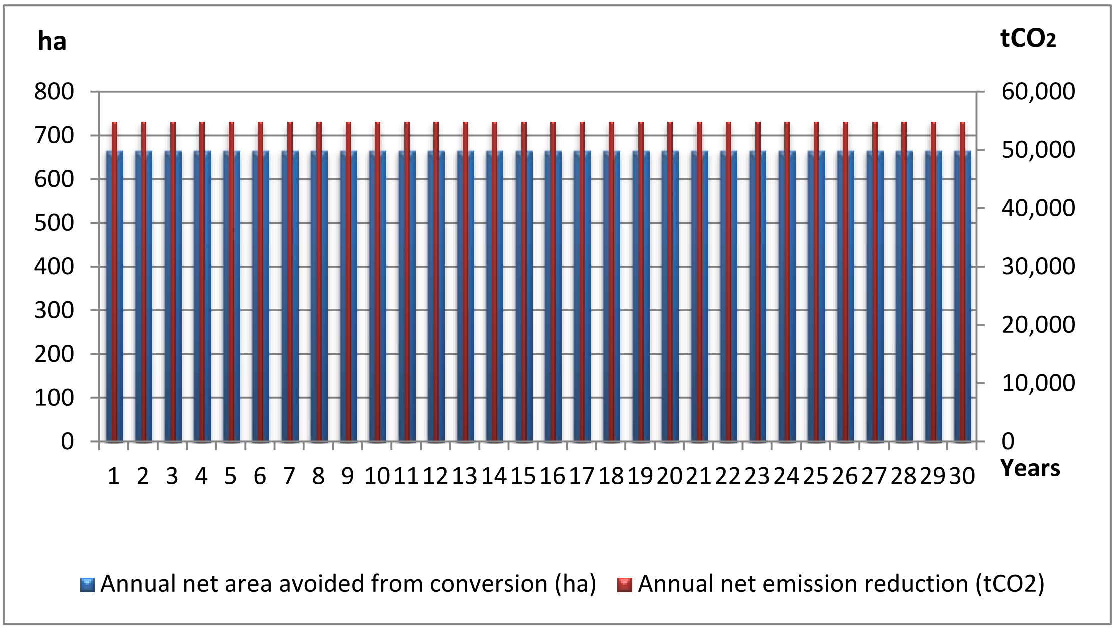
Institutional costs are related to public expenditures to build institutions and realize REDD+ at national scale. That includes governance structures, clarifications on land tenure issues, capacity building and extension services; policy formulation and law enforcement. The estimation of the institutional costs is based on a country wide average in US$/ha based on the total forested area in Tanzania and the budgets to build a national REDD+ framework.

In the following section, we initially provide estimates on the projected GHG benefits due to REDD+ activities and subsequently provide cost estimates on implementation costs, transaction costs and institutional costs.

REDD+ related GHG benefits projections

Based on the project documents we estimated that the project will annually prevent 667 ha equivalent to 55,000 tCO_2/yr of natural forest of being converted to other land uses, as shown in the figure below.

Figure 22: Avoided deforestation area and GHG benefits in project scenario



Implementation, Institutional and Transaction costs estimates

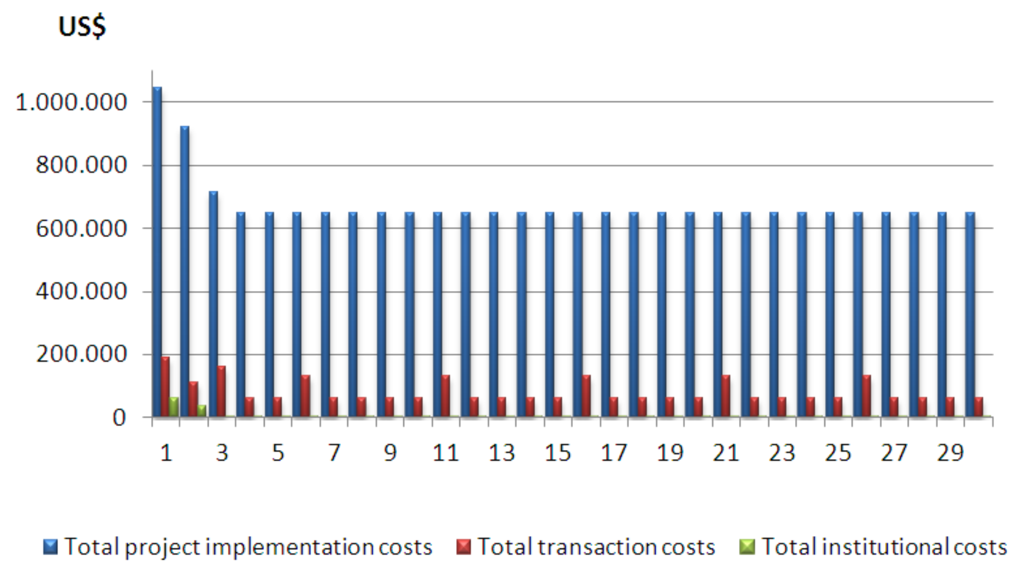
When implementing a REDD+ project, significant investments are required in order to cover the costs associated with actions to reduce deforestation, and hence emissions. All of these and similar measures incur up-front investment and perhaps recurring costs for public and/or the private sectors, which need to be adequately assessed and financed.

Based on the budget for the "Masito Ugalla Ecosystem pilot area in support of Tanzania's national REDD+ strategy" cost estimates were provided for the initial 3 years of the project lifetime. Based on these estimates we extrapolated the costs of the project for the subsequent 30 years.

In total, implementation costs are estimated at an annual average of US$ 0.67 million for the project area (US$ 20.2 million over 30 years)[7]; transaction cost are estimated at an average of US$ 80,500 annually (US$ 2.4 million over 30 years); and institutional costs will amount at US$ 5,300 (US$ 159,000 over 30 years). For a detailed cost breakdown, see the Excel-based tool to estimate REDD+ cost elements.

[7] Not taking into account inflation.

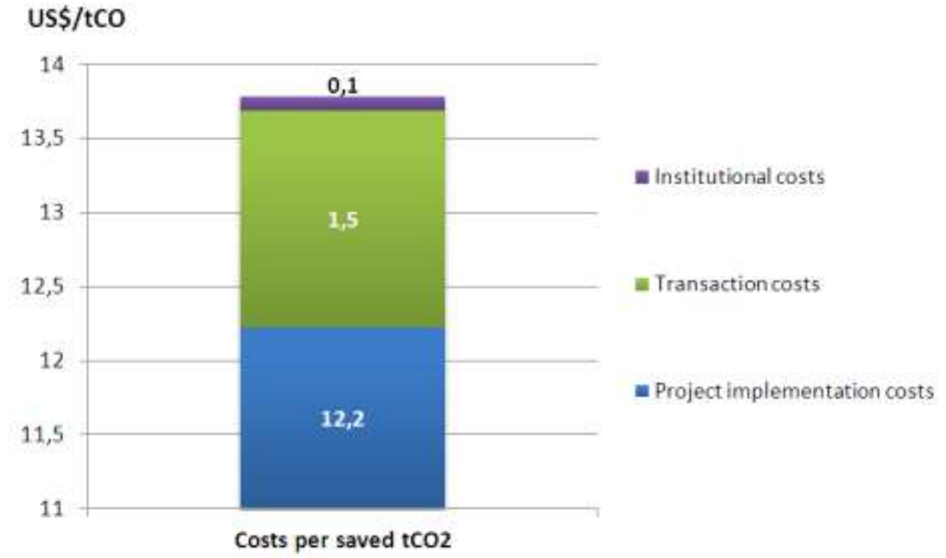
Figure 23: Annual implementation, transaction and institutional cost estimates (US$)



REDD+ costs per saved tCO_2

In the Jane Goodall Kigoma project a total a price of US$ 13.8 per conserved tCO_2 would be required in order to cover, implementation US$ 12.2/tCO_2), transaction (US$ 1.5/tCO_2) and institutional costs (US$ 0.1/tCO_2).

Figure 24: REDD+ costs per saved tCO2 (US$)



On the entire project scale and in order to avoid 1.65 million tCO_2 emissions, the costs would add up to about US$ 22.7 million over a project lifetime of 30 years.

Figure 25: Total project costs Jane Goodall Kigoma (US$)

Key assumption of 1-ha based land use economics

Natural forest

For the natural forest we assume that forest is used extensively for the collection of fuel wood and non-timber forest products in a sustainable manner.

Table 32: Natural forest assumptions (1 ha)

Annual costs	Quantity	Unit	Price per Unit	Quantity	Unit
Annual labor costs fuelwood collection	0	days/ha/yr			US$
Annual labor costs NTFP collection	30	days/ha/yr	3	90	US$
Annual cost small-scale timber extraction					
Harvesting	0	US$/$m^3$		0	US$
Timber transportation	0	US$/$m^3$		0	US$
Milling	0	US$/$m^3$		0	US$
Total costs				100	US$
Yields and Prices	**Quantity**	**Unit**	**Price per Unit**	**Quantity**	**Unit**
Annual fuel wood collection		m^3			US$
Annual NTFP collection	15	kg/ha	12.5	187.5	US$
Annual small-holder timber extraction revenues					
Annual timber extraction volume	0	m^3/ha/yr			
Waste	0%				
Quantity sold	0,0	m^3/ha/yr			
Price	0	US$/$m^3$		0	US$

Total revenues				187.5	US$

Source: Authors estimates

Unsustainable timber extraction

In this scenario we assume that unsustainable timber extraction takes place over a period of 7 years. The land is subsequently converted to shifting cultivation for the remaining 23 years.

Table 33: Unsustainable timber extraction assumptions (1 ha)

Key parameters	Value				
Years of timber extraction until land use change	7				
Alternative land use after clearance	Conventional agriculture (Shifting cultivation)				
Investment costs in year 0	**Quantity**	**Unit**	**Price per Unit**	**Quantity**	**Unit**
Land purchase	1	ha		0	US$
Land lease	1	ha		0	US$
Road network investments	1	m/ha	0	0	US$
Harvesting	0	US$/m^3		0	US$
Timber transportation	7	US$/m^3		6	US$
Milling	0	US$/m^3		0	US$
Stumpage fee	0	US$/m^3		0	US$
Labour days/ha/yr	6	US$/ha	3	18	US$

Total costs				24	US$
Annual costs from year 1 onwards	**Quantity**	**Unit**	**Price per Unit**	**Quantity**	**Unit**
Land lease	1	ha	0	0	US$
Annual road network investments	1	m/ha	0	0	US$
Harvesting	0	US$/m^3		0	US$
Timber transportation	0	US$/m^3		6	US$
Milling	0	US$/m^3		0	US$
Stumpage fee	0	US$/m^3		0	US$
Labour days/ha/yr	6	US$//ha	3	18	US$
Total costs				24	US$
Yields and Prices	**Quantity**	**Unit**			
Annual timber extraction volume	0,8	m^3/ha/yr			
Waste	0%				
Quantity sold	0,8	m^3/ha/yr			
Price	112,5	US$/m^3			
Total revenues	95	US$/ha			

Unsustainable fuel wood collection

In this scenario we assume that on one ha of forest, fuel wood extraction takes place in an unsustainable manner.

Table 34: Unsustainable fuel wood collection assumptions (1 ha)

Key parameters	Value	Unit	Source			
Years of fuel wood collection on a ha until clearance	30	Years	Authors estimates			
Alternative land use after clearance	No use after clearance					
Average aboveground biomass in year 0	36,8	tdm/ha	WWF, Malimbwi, Zahabu 2007			
Annual average biomass increment	2,4	tdm/ha/yr	WWF, Malimbwi, Zahabu 2007			
Total available fuelwood over collection period until clearance	108,8	tdm/ha				
Total annual commercial available fuelwood	3,6	tdm/ha/yr				
Inputs for firewood collection	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source:**
Labour input/yr	5,44	days	3	16,32	US$	Estimates from Masito Ugalla Kigoma
Total cost fuel wood collection				16,32	US$	
Income	**Quantity**	**Unit**	**Price per unit**	**Revenues**	**Unit**	**Source:**

Annual fuel wood per/ha	3,6	t/ha/yr	20	72,5	US$	Estimates from Masito Ugalla Kigoma
Total income				72,5	US$	

Agriculture (shifting cultivation)

As one of the drivers of deforestation in the project area, agriculture in form of shifting cultivation takes place. For the determination of the NPV for shifting cultivation, we used the following mix of cropping systems:

Table 35: Mix of cropping systems (agriculture shifting cultivation)

Land use distribution for subsistence agriculture	% of total of land use
Activity 1: Maize farming	30%
Activity 2: Beans	15%
Activity 3: Cassava	10%
Activity 4: Groundnuts	15%
Activity 5: Rice	30%
Total	100%

In addition we assume a land use cycle of 4 years of cultivation and 12 years of fallow which is repeated over a period of 30 years.

For each cropping system, we developed a 1-ha model as shown below, whereby the cost and revenues are estimated at the farm-gate level.

Table 36: Maize production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	Source:
Seed	10	kg	2,5	25	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	76	days	3	228	US$	
Total cost establishment				253,0		Estimates from project staff
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	
Seed	10	kg	2,5	25	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	46	days	3	138	US$	
Total cost management				163	US$	Estimates from project staff

Income	Quantity	Unit	Price per unit	Revenues	Unit	Source:
Yields /ha/yr	2500	kg/ha/yr	0,18	450	US$	Estimates from project staff
Yield start after establishment:	1	Year				
Total income				450	US$	

Table 37: Beans production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	Source
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools (hoes)	0,2	Units	3,1	0,62	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	180	days	3	540	US$	
Total cost establishment				541		Estimates from project staff
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source:**
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	

Tools	0,2	Units	3,1	0,62	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	180	days	3	540	US$	
Total cost management				541	US$	Estimates from project staff
Income	Quantity	Unit	Price per unit	Revenues	Unit	Source
Yields /ha/yr	1200	kg/ha/yr	0,875	1050	US$	Estimates from project staff
Yield start after establishment	1	year				
Total income				1050	US$	

Table 38: Cassava production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	Source
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	154	days	3	462	US$	

Total cost establishment				462		Agriculture and Forestry: The Masito-Ugalla Ecosystem (MUE), 2008
Inputs at management (from year 1 onwards)	Quantity	Unit	Price per unit	Costs	Unit	Source
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	20	days	3	60	US$	
Total cost management				60	US$	Agriculture and Forestry: The Masito-Ugalla Ecosystem (MUE), 2008
Income	Quantity	Unit	Price per unit	Revenues	Unit	Source
Yields /ha/yr	1	acre	375	375	US$	Estimates from project staff
Yield start after establishment:	1	Years				Estimates from project staff
Total income				375	US$	

Table 39: Groundnuts production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	Source
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	48	days	3	144	US$	
Total cost establishment				144		Agriculture and Forestry: The Masito-Ugalla Ecosystem (MUE), 2008
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	48	days	3	144	US$	
Total cost management				144	US$	Estimates from project staff

Income	**Quantity**	**Unit**	**Price per unit**	**Revenues**	**Unit**	**Source**
Yields /ha/yr	250	kg/ha/yr	2,5	625	US$	Estimates from project staff
Yield start after establishment:	1	Year				
Total income				625	US$	

Table 40: Rice production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	Source
Seedling	400	plants	0,125	50	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	XXX	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	90	days	2,5	225	US$	
Total cost establishment				275		Estimates from project staff
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Seedlings	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	

Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	
Tools	0	XXX	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	110	days	2,5	275	US$	
Total cost management				275	US$	Estimates from project staff
Income	Quantity	Unit	Price per unit	Revenues	Unit	Source
Yields /ha/yr	3000	kg/ha/yr	0,625	1875	US$	Estimates from project staff
Yield start after establishment:	1	Year				
Total income				1875	US$	

Pasture (Cattle grazing)

In this scenario, we assume that cattle grazing is one driver deforestation on the project area. Thereby we make the following assumptions:

Table 41: Pasture (cattle) key assumptions (1-ha)

CATTLE	Quantity	Units	Source			
Average livestock/ha	2	Units/ha	Authors estimates			
Annual average milk production (liters/animal)	2555	liters/cow/yr				
Annual average meat production/animal	18	kg/yr				
Ratio of dairy cattle	70%	%				

Ratio of meat production cattle	30%	%				
Annual organic fertiliser production/use	0	kg/ha/yr				
Inputs at establishment (year 0)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Purchase livestock/ha (Cattle)	2	Animals/ha	0	0	US$	
Shed, corral, equipment	0	US$/ha/yr		0	US$	
Land preparation	20	days/labour	3	60	US$	
Pasture seeding	0	US$/ha/yr		0	US$	
Fences	0	Meters	0	0	US$	
Land rental	0	US$/ha/yr		0		
Labour input/yr	100	days	3	300	US$	
Total cost establishment				360		
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	
Supplements	0	kg	0	0	US$	
Animal health	0	US$/ha/yr		0	US$	
Maintenance	0	US$/ha/yr		0	US$	
Land rental	0	US$/ha/yr		0	US$	
Labour input/yr	100	days	3	300	US$	
Total cost management				300		

Income seeling/Value of self-consumption	Quantity	Unit	Price per unit	Revenue	Unit	
Milk/ha/yr	3577	liters/year	0,125	447,125	US$	
Animal value when sold	0,5	Annual animal production /ha	1,6875	0,84375	US$	
Value of organic fertilizer	0	kg/ha/yr	0	0	US$	
Total income				448		

Annex 3 – Mpingo Conservation and Development Initiative

Summary Report

Modeling approach and key assumptions

In the framework of the assignment *Estimating Cost elements of REDD+ in Tanzania* funded by the UN-REDD Programme, the consultants team developed a methodology to estimate opportunity costs, implementation costs, institutional costs and transaction costs of REDD+ projects, specified to Tanzanian circumstances. The Excel-based model is designed in a manner allowing to use the Excel data as input data for the REDD ABACUS software (Beta Version: 1.1.1 beta1 (13 Dec 2011[8])) that automatically generates opportunity cost curves.

The Excel-based model is designed in an iterative manner and requires the user to initially identify the persistent land use types at a historical point in time and at the project start and undertake a land use classification and assessment of the carbon stock data for the identified land use types.

Afterwards 1-ha based land use economics are calculated to generate a NPV value for all identified land use types. In the opportunity cost analysis stage a land use change matrix has to be developed that reflect the historical land use change patterns and to which land use types forest have been converted. If there is no historical conversion of forest to other land uses opportunity costs do not appear and no opportunity cost curves can be generated.

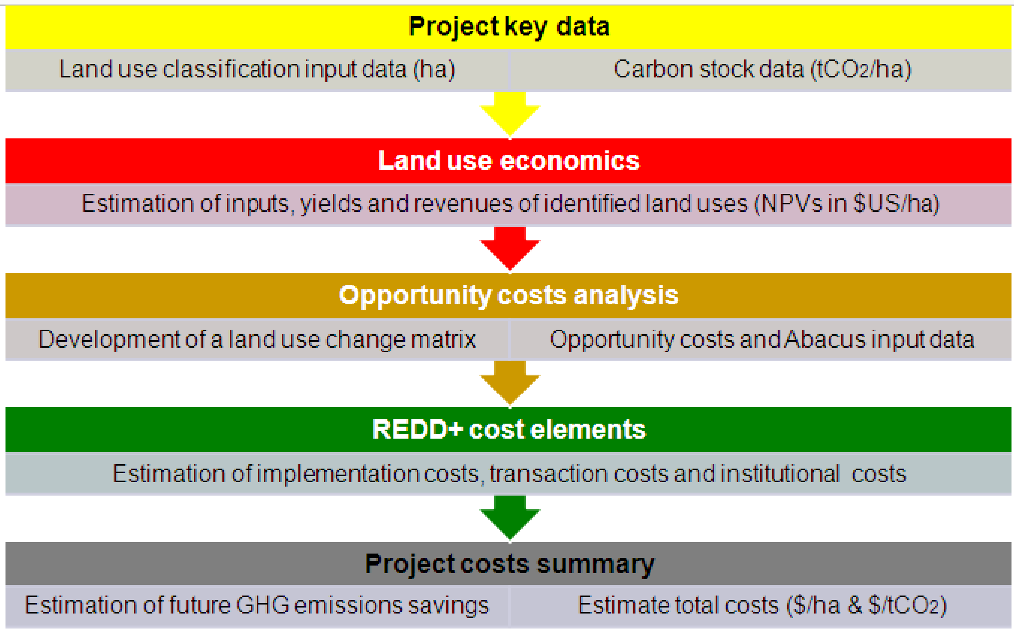
Main outputs of processing the 1-ha economic models are Net Present Values (NPVs) as explained in the main report and land use related carbon stock changes. Based on this output all required input data for REDD ABACUS is generated and opportunity cost curves can be processed with ABACUS.

In the subsequent phase other REDD+ cost elements, namely institutional, implementation and transaction costs are estimated. While the transaction costs and implementation costs are derived from the project documents, institutional costs are calculated from a national average.

[8] http://www.worldagroforestry.org/sea/abacus

The model allows estimating all four REDD+ cost elements. Hence, indicating REDD+ costs for the envisaged GHG emission savings/GHG removals by the project.

Figure 26: Methodology to estimate REDD+ cost elements



Project key area and carbon stock assumptions

The Mpingo Conservation and Development Initiative is a project without historical deforestation pressures and is seeking to convert natural forest use (under regular fire) to sustainable forest production certified according to the FSC and to the VCS as an improved forest management project (IFM) that enhances carbon stocks .

For the project model we used input data from the project documents provided to the consultants and a project specific workshop in Dar es Salaam on 13 February 2012.

During the discussion with project staff it appeared that historically there has not been deforestation due to human-induced activities, thus no opportunity costs had arisen historically. The project team mentioned that the natural forest has been regularly under fire, but a reference emissions level has not been determined and the area affected by fire has not been determined, yet.

In order to compare the profitability of the different land uses and the opportunity costs of changing land use from natural forest to sustainable timber production we hypothetically assumed the conversion of 1 ha from natural forest to sustainable timber production, modeled the opportunity costs in order to make projections on the most opportunity costs when converting unmanaged natural forest to sustainable timber production. The following assumptions were made:

Table 42: Project area assumptions

Land use types of the project area (ha):	Historical land use on project area (ha)	At project start (ha)
Natural forest (under regular fire)	30,001	30,000
Sustainable timber extraction	0	1
Total	30,001	30,001

Carbon stock data of land use types

For the carbon stock data the long-term average carbon stocks shall be used. Based on provided data and our own estimates, the following carbon information was generated and used in our further calculations:

Table 43: Carbon stock assumptions

Land use types	Carbon stocks (ABG) (tCO_2/ha)	Carbon stocks (ABG, BGB) (tC/ha)
Natural forest	73	19.9
Sustainable timber extraction	110	30

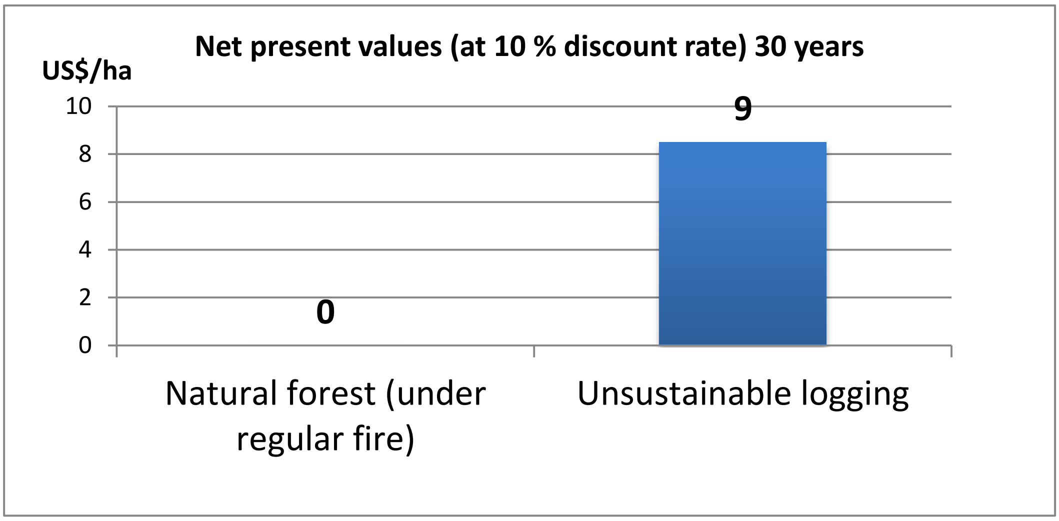
Note: The long-term average carbon stocks is based on data from Mpingo project staff and the assumption that the conversion of natural forest to sustainable timber extraction will result in an increase of 37 tCO_2/ha over a period of 30 years.

1-ha models for existing land use types

For the establishment of opportunity costs each identified land use type requires the establishment of a Net Present Value (NPV), an economic performance indicator that shows the profitability of a land use in US$/ha. For the NPV calculation we used a discount rate of 10 % and discounted the annual cost and revenues over a period of 30 years, equivalent to the project lifetime.

The figure below presents the NPVs for the identified land uses. According to the Mpingo project staff there has not been a forest use, due to its distance to populated areas, thus it was recommended to set the NPV of natural forest at US$ 0/ha. It the project scenario the management of 1 ha sustainable timber production would result in a NPV of US$ 9/ha over a period of 30 years (discount rate 10 %). All key assumptions made in these 1-ha models are detailed in Annex 1.

Figure 27: NPV for the Mpingo Conservation and Development Initiative



Opportunity costs

The opportunity cost were calculated based on carbon stock changes (tCO_2/ha) from the conversion of natural forest (under regular fire) to sustainable timber production which would result in a net gain of 37 tCO_2/ha over 30 years.

Using the NPV (and the respective carbon stock data, for each land use, we calculated negative opportunity costs of US$ -0.2/tCO_2. In other words, each additional tCO_2 that will be sequestered in sustainable timber extraction land use will result in a net gain of US$ 0.2. In total, this would lead to an increase the NPV from US$ 0/ha (natural forest under regular fire) to US$ 9/ha (sustainable timber extraction).

Building the REDD+ SFM project case

The previous sections identified the potential carbon stock changes and NPVs for the natural forest and sustainable forest management on 1 ha. In the project case, the entire project area will be subject to sustainable management, thus comprising, implementation costs, transaction costs and institutional costs. For detailed explanation, refer to the main report.

Implementation costs are directly associated with actions to reduce deforestation and forest degradation. Examples include the costs of guarding a forest to prevent unsustainable timber extraction, replanting trees in degraded or logged forests, or intensifying agriculture or cattle ranching. Implementation may also comprise the training and capacity-building activities at the project level that are necessary to make the REDD+ programs happen.

For the implementation and transaction costs we used the annual project budget of the Mpingo Conservation and Carbon project documents , also taking into account the funding provided by the Royal Norwegian Embassy between 2009 and 2013 (US$ 1.9 million).

Transactions costs are incurred throughout the process: certifying the project according to a carbon standard, transaction negotiation, monitoring, reporting, and verifying GHG emission reductions. Transaction costs are incurred by the implementers of a REDD+ program and third parties such as verifiers, certifiers, and lawyers.

Institutional costs are related to public expenditures to build institutions and realize REDD+ at national scale. That includes governance structures, clarifications on land tenure issues, capacity building and extension services; policy formulation and law enforcement. The estimation of the institutional costs is based on a country wide average in US$/ha based on the total forested area in Tanzania and the budgets to build a national REDD+ framework.

In the following, we initially provide estimates on the projected GHG benefits due to REDD+ activities and subsequently provide cost estimates on implementation costs, transaction costs and institutional costs.

REDD+ related GHG benefits projections

Based on the project documents we estimated that the project will annually enhance carbon stocks on the 30,000 ha area by about 37,000 tCO_2/yr, equivalent to 1.23 tCO_2/ha/yr[9].

Implementation, Institutional and Transaction costs estimates

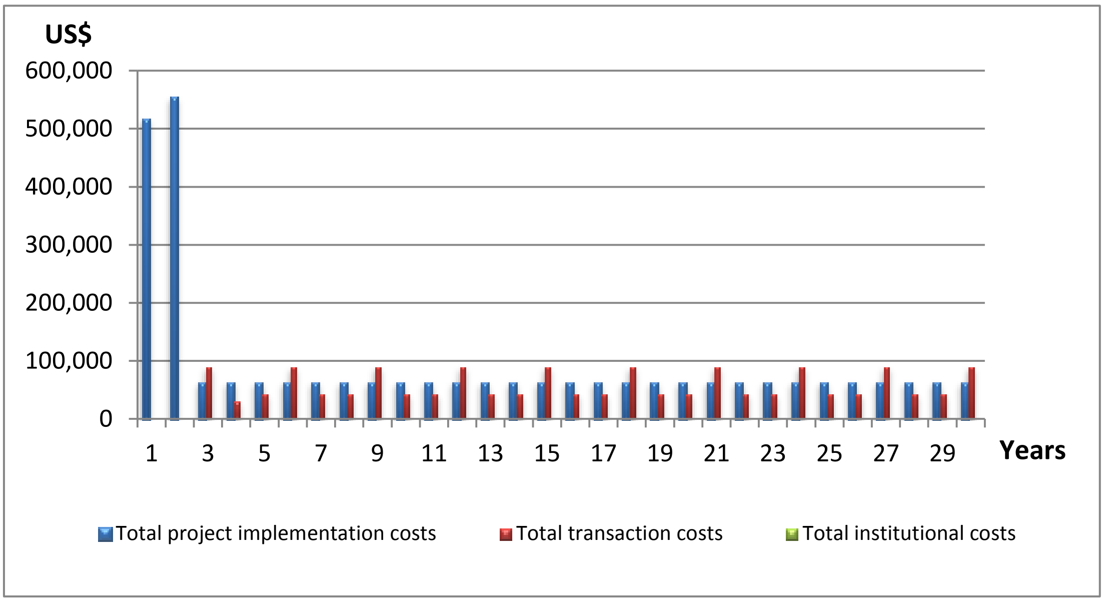
When implementing a REDD+ project, significant investments are required in order to cover the costs associated with actions develop the project and establish the capacity to implement the project. All of these and similar measures incur up-front investment and perhaps recurring costs for public and/or the private sectors, which need to be adequately assessed and financed.

Based on the budget for the submitted to the Norwegian Royal Embassy and further future cost projection by the project staff, we estimated implementation costs at an annual average of US$ 0.12 million for the project area (US$ 3.7 million over 30 years)[10]; transaction cost are estimated at an average of US$ 56,000 annually (US$ 1.69 million over 30 years); and institutional costs will amount at US$ 1,000 (US$ 30,000 over 30 years).

[9] Assumption is made that carbon stocks will change from 73 tCO2/ha in natural forest stage and 110 tCO2/ha in the sustainable forest management stage, over a period of 30 years.

[10] Not taking into account inflation.

Figure 28: Annual implementation, transaction and institutional cost estimates (US$)



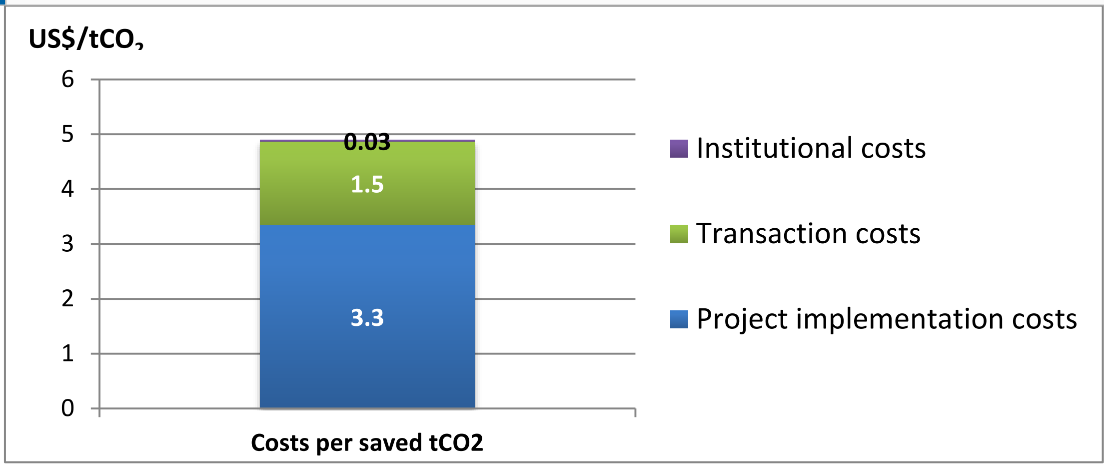
Note: Implementation cost: For the first three years we used the budgets as submitted to the Royal Norwegian Embassy. Subsequently we used estimates from the Mpingo project staff.

REDD+ SFM costs per saved tCO_2

In this section we assume that no opportunity costs will arise due net benefits of converting unmanaged natural forest to sustainable timber management. With regards to the implementation, transaction and institutional costs, we sum up all these cost elements that will appear over the project lifetime and divide these by the expected GHG removals due to SFM project activities. The potential revenues apart from carbon are not included in the calculation.

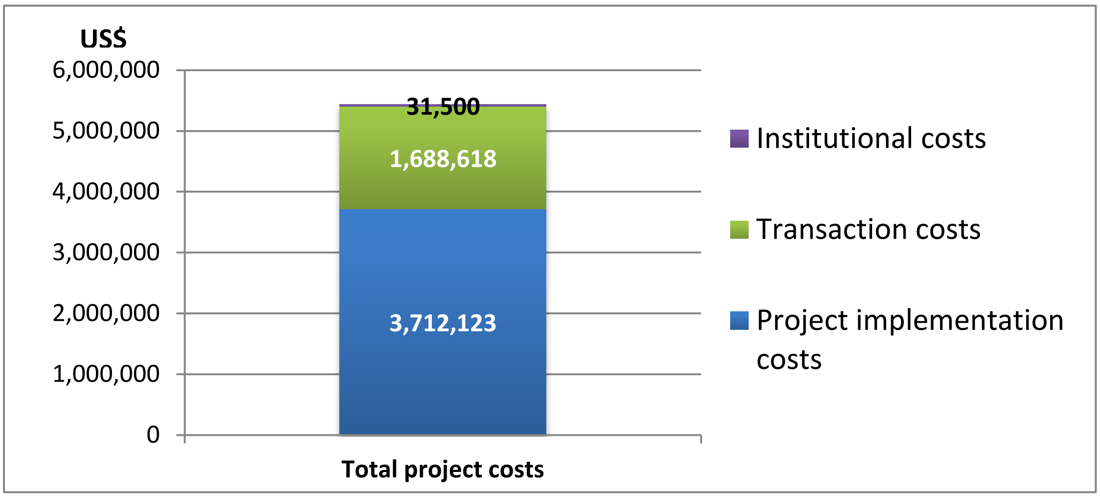
A total price of US$ 4.9 per removed tCO_2 would be required in order to cover the implementation (US$ 3.3/tCO_2), transaction (US$ 1.5/tCO_2) and institutional costs (US$ 0.03/tCO_2).

Figure 29: SFM costs per tCO2 removal (US$)



On the entire project scale the enhancement of 1.1 million tCO_2, would add up to about US$ 5.4 million over a project lifetime of 30 years.

Figure 30: Total project costs Mpingo Conservation and Development Initiative (US$)



Key assumptions of 1-ha based land use economics

Natural forest

For the natural forest we assume that forest is not used due to the long distance to the human population as recommended by Mpingo project staff, thus the NPV value is US$ 0.

Sustainable timber extraction

In this scenario we assume that unsustainable timber extraction takes place over a period of 7 years. The land is subsequently converted to shifting cultivation for the remaining 23 years.

Table 44: Unsustainable timber extraction assumptions (1 ha)

Investment costs in year 0	Quantity	Unit	Price per Unit	Quantity	Unit
Land purchase	1	ha	0	0	US$
Land lease	1	ha	0	0	US$
Road network investments	1	m^3/ha	0	0	US$
Harvesting	0	US$/$m^3$		0	US$
Timber transportation	0	US$/$m^3$		0	US$
Milling	0	US$/$m^3$		0	US$
Stumpage fee	0	US$/$m^3$		0	US$
Total costs				12,5	US$
Annual costs in year 1	**Quantity**	**Unit**	**Price per Unit**	**Quantity**	**Unit**

Land lease	1	ha	0	0	US$
Annual road network investments	1	m^3/ha	0	0	US$
Harvesting	23	US$/$m^3$		0	US$
Timber transportation	20	US$/$m^3$		0	US$
Milling	0	US$/$m^3$		0	US$
Stumpage fee	0	US$/$m^3$		0	US$
Total costs				1	US$
Yields and Prices	**Quantity**	**Unit**	**Source**		
Annual timber extraction volume	0	m^3/ha/yr			
Waste	35%				
Quantity sold	0,0				
Price	0	US$/$m^3$	Authors estimate		
Total revenues	3,0	US$/ha			

Annex 4 – TFCG Mjumita – Kilosa Project

Summary Report

Modeling approach and key assumptions

In the framework of the assignment *Estimating Cost elements of REDD+ in Tanzania* funded by the UN-REDD Programme, the consultants team developed a methodology to estimate opportunity costs, implementation costs, institutional costs and transaction costs of REDD+ projects, specified to Tanzanian circumstances. The Excel-based REDD+ cost element model is designed in a manner allowing to use the Excel data as input data for the REDD ABACUS software (Beta Version: 1.1.1 beta1 (13Dec2011[11])) that automatically generates opportunity cost curves.

The Excel-based tool is designed in an iterative manner and requires the user to initially identify the persistent land use types at a historical point in time and at the project start and undertake a land use classification and assessment of the carbon stock data for the identified land use types.

Afterwards 1-ha based land use economics are calculated to generate a NPV value for all identified land use types. In the opportunity cost analysis stage a land use change matrix has to be developed that reflect the historical land use change patterns and to which land use types forest have been converted. If there is no historical conversion of forest to other land uses opportunity costs do not appear and no opportunity cost curves can be generated.

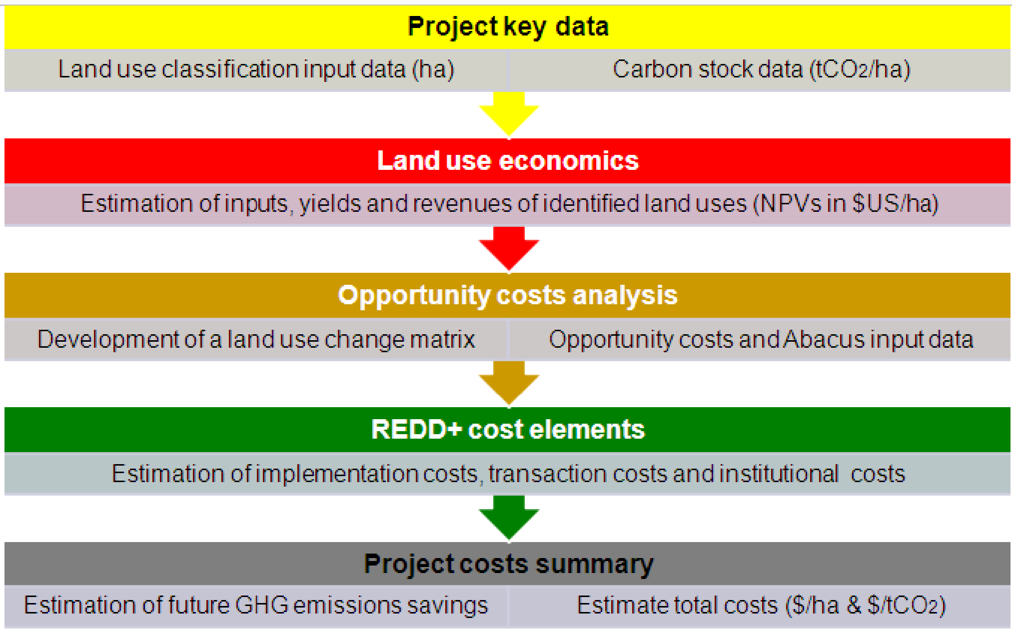
Main outputs of processing the 1-ha economic models are Net Present Values (NPVs) as explained in the main report and land use related carbon stock changes. Based on this output all required input data for REDD ABACUS is generated and opportunity cost curves can be processed with ABACUS.

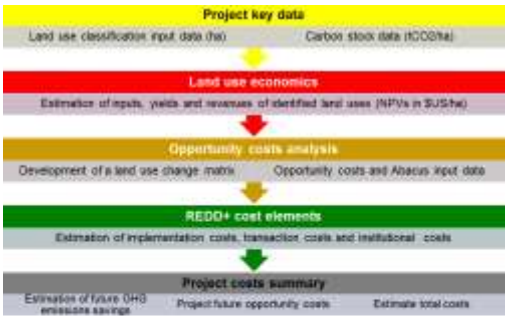
In the subsequent phase other REDD+ cost elements, namely institutional, implementation and transaction costs are estimated. While the transaction costs and implementation costs are derived from the project documents, institutional costs are calculated from a national average.

[11] http://www.worldagroforestry.org/sea/abacus

The model allows estimating all four REDD+ cost elements. Hence, indicating REDD+ costs for the envisaged emission savings by the project.

Figure 31: Methodology to estimate REDD+ cost elements





Project key area and carbon stock assumptions

For the TFCG Mjumita – Kilosa project model we used input data from the project documents provided to the consultants and a project specific workshop in Dar es Salaam on the 13th February, 2012.

With regards to the drivers of deforestation, we used unsustainable charcoal production and shifting cultivation as the major drivers.

Table 45: Project area assumptions		
Land use types of the project area (ha):	Historical land use on project area (ha)	At project start (ha)
Natural forest	148,825	139,617
Unsustainable charcoal production	0	4,236
Agriculture (Shifting cultivation)	0	4,972
Total	148,825	148,825

Carbon stock data of land use types

For the carbon stock data the long-term average carbon stocks shall be used. Based on provided data and our own estimates, the following carbon information was generated and used in our further calculations:

Table 46: Carbon stock assumptions		
Land use types	Carbon stocks (ABG, BGB) (tCO_2/ha)	Carbon stocks (ABG, BGB) (tC/ha)
Natural forest	145.3	39.6
Unsustainable charcoal production	16.1	4.4
Agriculture (Shifting cultivation)	16.1	4.4

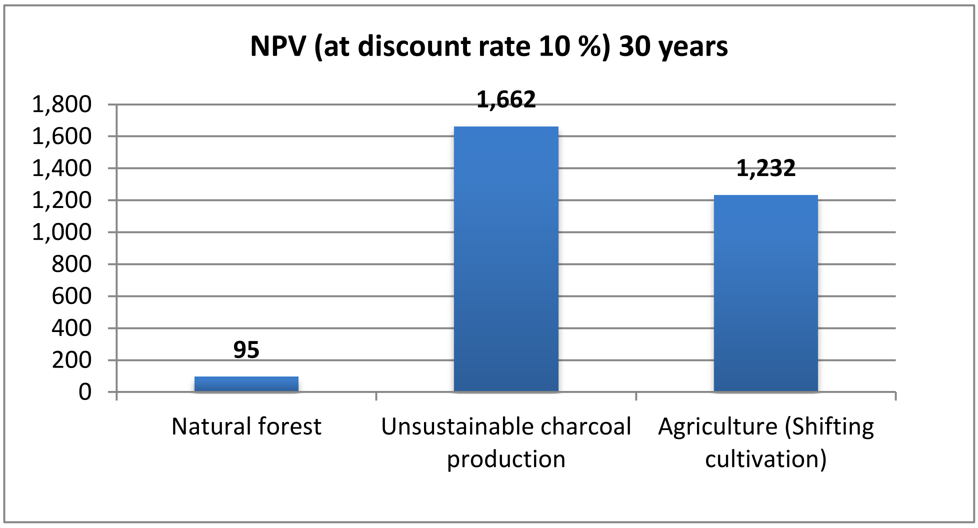
Note: The long-term average is based on the average aboveground carbon stock carbon stock is based on a weighted average carbon stock from 17 forest plots randomly distributed across the project area. Belowground carbon stocks are based on IPCC default root-to-shoot ratio for dry tropical forests.

1-ha models for existing land use types

For the establishment of opportunity costs curves each identified land use type requires the establishment of a Net Present Value (NPV), an economic performance indicator that shows the profitability of a land use in US$/ha. For the NPV calculation we used a discount rate of 10 % and discounted the annual cost and revenues over a period of 30 years, equivalent to the project lifetime.

The figure below presents the NPVs for the identified land uses. All key assumptions made in these 1-ha models are detailed in Annex 1.

Figure 32: NPVs for the TFCG Mjumita – Kilosa project



Land use change matrix

The land use change matrix is a key input for the opportunity cost analysis spreadsheet which is also used as an input table for ABACUS. It provides information about the land use change dynamics in the project area. In addition to providing data needed for the opportunity cost analysis, the land use change matrix can be used to assess the driving forces of deforestation and land use trajectories over time. The land use change matrix is normally based on the historical remote sensing analysis that compares land uses at two different points in time, e.g. 2001 and 2011.

Table 47: Land use change matrix for project (2001-2011) (ha) presents the estimated land use change matrix for the project case. The vertical column indicates the year of the initial land cover. The change to another land use is shown on the horizontal row. The diagonal of the table indicates unchanged land area units between two time series (in orange font). The figures in green font indicate the conversion of natural forest at an historical point in time to different other land use types, identified as the drivers of deforestation at the current point of time (e.g. at project start).

The total value at the end of the first row is the area in natural forest at the historical point of time (148,825 ha). The total value at the bottom of the second column is the total area in natural forest at project start (139,617 ha). Therefore the study area lost 9,208 ha of forest between 2001 and 2011.

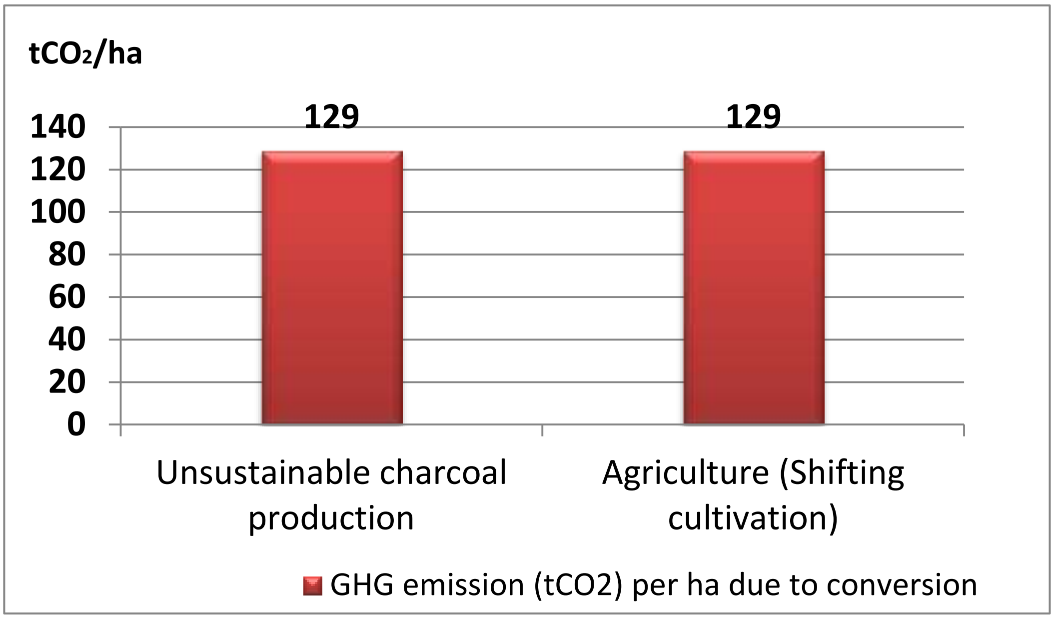
Table 47: Land use change matrix for project (2001-2011) (ha)

Initial (change from initial land cover) / Final (change to final stage/latest land cover classification) (ha)	Natural forest	Unsustainable charcoal production	Agriculture (Shifting cultivation)	Total
Natural forest	139,617	4,236	4,972	148,825
Unsustainable charcoal production		0		0
Agriculture (Shifting cultivation)			0	0
Total	139,617	4,236	4,972	148,825

Opportunity costs

The opportunity cost were calculated based on the following carbon stock losses (tCO_2/ha) from the conversion of natural forest to the respective land use types.

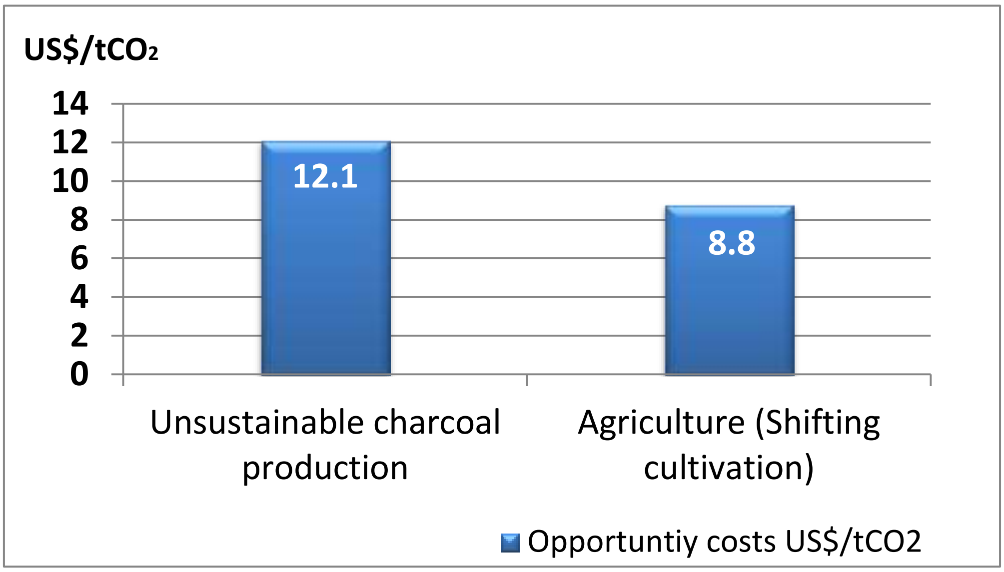
Figure 33: GHG emissions (tCO2/ha) from conversion of natural forest to other land use types in the TFCG – Mjumita Kilosa project area



Using the NPV and the respective carbon stock data, for each land use, the following opportunity costs (US$/$tCO_2$) were calculated by dividing the opportunity cost NPV (Figure 32) for the land use change by the related carbon stock change (Table 46) per ha.

In the TFCG Kilosa project case the opportunity costs would range between US$ 12.1/tCO_2 for unsustainable charcoal production and subsequent shifting cultivation and US$ 8.8/tCO_2 for agriculture (shifting cultivation). Thus, avoiding land use conversion from natural forest to unsustainable charcoal production and shifting cultivation would comprise a higher NPV than of the natural forest. These opportunity costs indicate which monetary value will forgo the user, when not converting the forest.

Figure 34: Opportunity costs (US$/tCO2) from conversion of natural forest to other land use types in the TFCG Mjumita Kilosa project

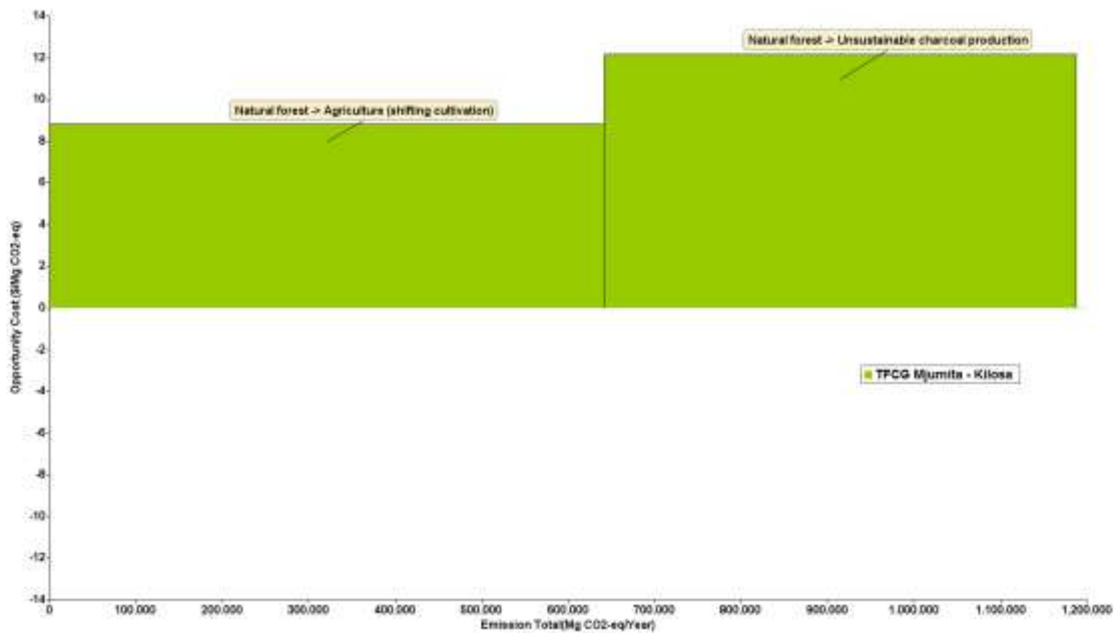


The described data (NPV and land use change matrix based carbon stock changes) constitute the key input data for the ABACUS software to generate the project`s opportunity cost curves.

An opportunity cost curve compares the quantity of potential emission reductions with their opportunity costs. The vertical y-axis represents the opportunity cost of the emissions reduction option (in US$ per tCO_2), while the horizontal axis depicts the corresponding quantity of reduction (in million tCO_2) at the respective price.

For the described land use change scenario (land use matrix) emissions of about 1.2 million tCO_2 would occur over a period of 10 years.

Figure 35: Opportunity cost curve TFCG Mjumita - Kilosa project



Note: The GHG emissions in the cost curve occurred over a period of the last 10 years, as based on historical land use change indicated in the land use change matrix.

Building the REDD+ project case

The opportunity cost curves is based on historical data and land use dynamics. In order to estimate the complete REDD+ project cost elements, implementation costs, transaction costs and institutional costs need to be estimated. In our calculation we assume that opportunity costs will be compensated by the implementation activities, thus opportunity costs are not added up to total costs. For detailed explanation, refer to the main report.

Implementation costs are directly associated with actions to reduce deforestation and forest degradation. Examples include the costs of guarding a forest to prevent unsustainable charcoal production, replanting trees in degraded or logged forests, or intensifying agricultural land. Implementation may also comprise the training and capacity-building activities at the project level that are necessary to make the REDD+ programs happen.

For the implementation and transaction costs we used the annual project budget of the TFCG Mjumita project proposal financed by the Royal Norwegian Embassy Norway and assigned the respective cost the implementation and transaction cost categories.

Transactions costs are incurred throughout the process: certifying the project according to a carbon standard, transaction negotiation, monitoring, reporting, and verifying GHG emission reductions. Transaction costs are incurred by the implementers of a REDD+ program and third parties such as verifiers, certifiers, and lawyers.

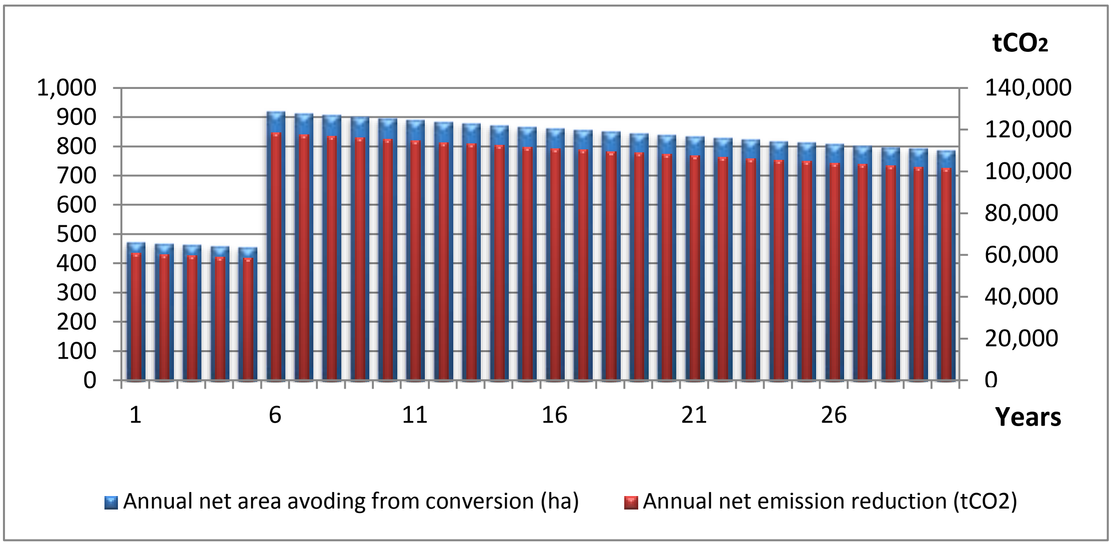
Institutional costs are related to public expenditures to build institutions and realize REDD+ at national scale. That includes governance structures, clarifications on land tenure issues, capacity building and extension services; policy formulation and law enforcement. The estimation of the institutional costs is based on a country wide average in US$/ha based on the total forested area in Tanzania and the budgets to build a national REDD+ framework.

In the following, we initially provide estimates on the projected GHG benefits due to REDD+ activities and subsequently provide cost estimates on implementation costs, transaction costs and institutional costs.

REDD+ related GHG benefits projections

Based on inputs from TFCG Mjumita project staff we estimated that the project will on average prevent 790 ha/yr of natural forest of being converted to other land uses equivalent to 102,000 tCO_2/yr, as shown in the figure below.

Figure 36: Avoided deforestation area and GHG benefits in project scenario



Implementation, Institutional and Transaction costs estimates

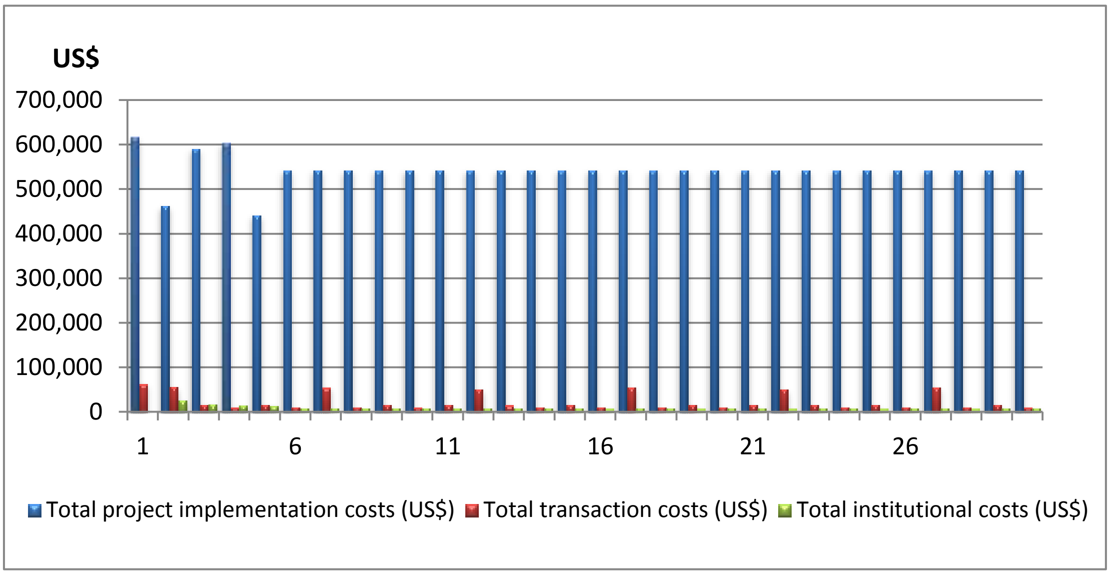
When implementing a REDD+ project, significant investments are required in order to cover the costs associated with actions to reduce deforestation, and hence emissions. All of these and similar measures incur up-front investment and perhaps recurring costs for public and/or the private sectors, which need to be adequately assessed and financed.

Based on the budget for the TFCG Mjumita Lindi and Kilosa project budget area cost estimates were provided for the initial 5 years of the project lifetime. Based on these estimates we extrapolated the costs of the project for the subsequent 25 years.

In total, implementation costs are estimated at an annual average of US$ 0.55 million for the project area (US$ 16.35 million over 30 years)[12]; transaction cost are estimated at an average of US$ 25,000 annually (US$ 0.75 million over 30 years); and institutional costs will amount at US$ 10,500 (US$ 0,32 over 30 years). For a detailed cost breakdown, see the Excel-based tool to estimate REDD+ cost elements.

[12] Not taking into account inflation.

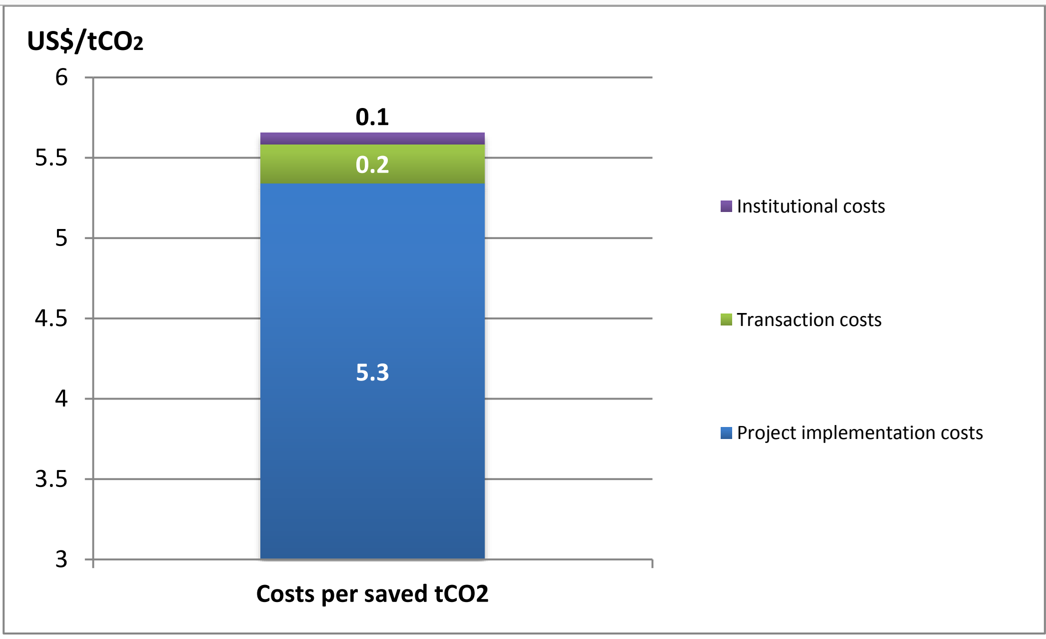
Figure 37: Annual implementation, transaction and institutional cost estimates (US$)



REDD+ costs per saved tCO_2

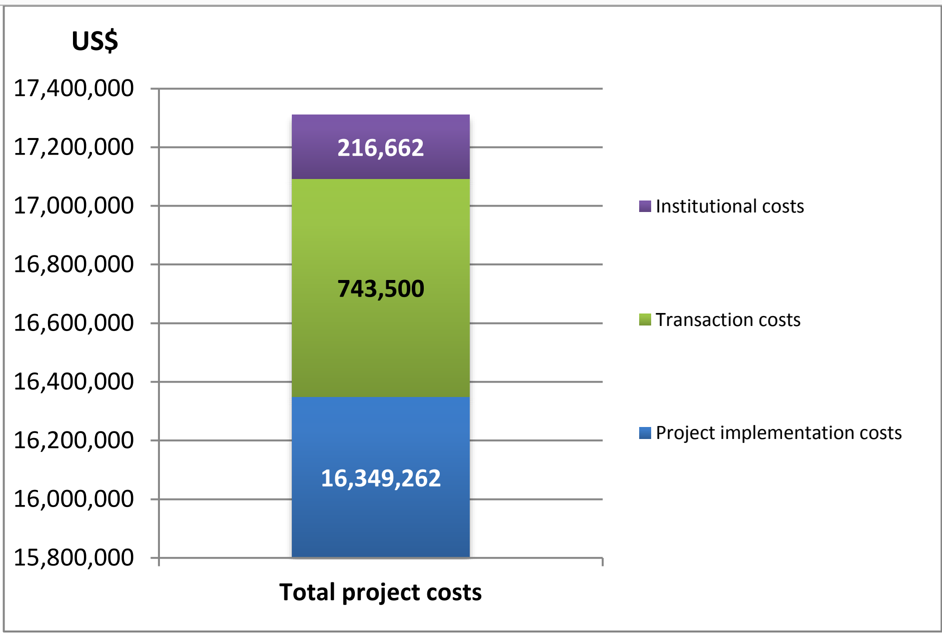
In the TFCG Mjumita Kilosa project a total a price of US$ 5.6 per conserved tCO_2 would be required in order to cover implementation US$ 5.3/tCO_2), transaction (US$ 0.2/tCO_2) and institutional costs (US$ 0.1/tCO_2).

Figure 38: REDD+ costs per saved tCO2 (US$)



On the entire project scale and in order to avoid 3.1 million tCO_2 emissions, the costs would add up to about US$ 17.3 million over a project lifetime of 30 years.

Figure 39: Total project costs TFCG Mjumita Kilosa (US$)



Key assumption of 1-ha based land use economics

Natural forest

For the natural forest we assume that forest is used extensively for the collection of fuel wood and non-timber forest products in a sustainable manner.

Table 48: Natural forest assumptions (1 ha)

Annual costs	Quantity	Unit	Price per Unit	Quantity	Unit
Annual labour costs fuelwood collection	15	days/ha/yr	2	30	US$
Annual labour costs NTFP collection	15	days/ha/yr	2	30	US$
Annual cost small-scale timber extraction					
Harvesting	0	US$/m³		0	US$
Timber transportation	0	US$/m³		0	US$
Milling	0	US$/m³		0	US$
Total costs				60	US$
Yields and Prices	**Quantity**	**Unit**	**Price per Unit**	**Quantity**	**Unit**
Annual fuel wood collection	1,5	m³	20	30	US$
Annual NTFP collection	10	Units	4	40	US$
Annual small-holder timber extraction revenues					
Annual timber extraction volume	0	m³/ha/yr			

Waste	0%				
Quantity sold	0,0	m^3/ha/yr			
Price	0	US$/$m^3$		0	US$
Total revenues				70	US$

Source: Authors estimates

Unsustainable charcoal production

In this scenario we assume that unsustainable charcoal production takes place over a period of 1 year, and subsequently converted to shifting cultivation for the remaining 29 years.

Table 49: Unsustainable charcoal productions assumptions (1 ha)

Key parameters	Value	Unit	Source			
Years of charcoal production on a ha until clearance	1	Years	Authors estimates			
Alternative land use after clearance	Conventional agriculture (Shifting cultivation)					
Average aboveground biomass in year 0	28	tdm/ha	TFCG estimates			
Annual average biomass increment	2,4	tdm/ha	WWF, Malimbwi, Zahabu 2007			
Total commercially available biomass	30,4	tdm/ha				
Total annual commercially available biomass	30,4	tdm/ha/yr				
Average kiln efficiency	20%		Drivers of Deforestation in Kilwa Excel sheet			

Total annual commercially available charcoal	6,1					
Inputs for charcoal production	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Labour input (harvesting and charcoal making)	112	days/ha/yr	2	224	US$	Calculated from data in WWF, Malimbwi, Zahabu 2007
Tools and equipment	0	Units	0	0	US$	
Total cost charcoal production				224	US$	
Income	**Quantity**	**Unit**	**Price per unit**	**Revenues**	**Unit**	**Source**
Annual charcoal production	6,1	t/ha/yr	100	608	US$	Calculated from data in WWF, Malimbwi, Zahabu 2007
Total income charcoal				608	US$	

Agriculture (shifting cultivation)

As one of the major drivers of deforestation in the project area shifting cultivation is commonly practiced. For the determination of the NPV shifting cultivation, we used beans as the sole crop which is the most profitable cropping system in the project region. This is due to the lack of data on the mix of cropping systems. Thus the opportunity costs are likely to be overestimated as other less profitable crops are grown.

Table 50: Mix of cropping systems (agriculture shifting cultivation)	
Land use distribution for subsistence agriculture	% of total of land use
Activity 1: Beans	100%

In addition we assume a land use cycle of 5 years of cultivation and 8 years of fallow which is consistently repeated over a period of 30 years. For beans cropping system, we developed a 1-ha model as shown below, that estimates the cost and revenues at the farm-gate level.

Table 51: Beans production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	210	days	2	420	US$	Business outlook Mjumita TFCG REDD Kilosa
Total cost establishment				420		
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	

Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	168	days	2	336	US$	Business outlook Mjumita TFCG REDD Kilosa
Total cost management				336	US$	
Income	**Quantity**	**Unit**	**Price per unit**	**Revenues**	**Unit**	**Source**
Yields /ha/yr	1482	kg/ha/yr	0,4	593	US$	Business outlook Mjumita TFCG REDD
Yield start after establishment	1	year				
Total income				593	US$	

Annex 5 – TFCG Mjumita – Lindi Project

Summary Report

Modeling approach and key assumptions

In the framework of the assignment *Estimating Cost elements of REDD+ in Tanzania* funded by the UN-REDD Programme, the consultants team developed a methodology to estimate opportunity costs, implementation costs, institutional costs and transaction costs of REDD+ projects, specified to Tanzanian circumstances. The Excel-based REDD+ cost element model is designed in a manner allowing to use the Excel data as input data for the REDD ABACUS software (Beta Version: 1.1.1 beta1 (13 Dec 2011[13])) that automatically generates opportunity cost curves.

The Excel-based tool is designed in an iterative manner and requires the user to initially identify the persistent land use types at a historical point in time and at the project start and undertake a land use classification and assessment of the carbon stock data for the identified land use types.

Afterwards 1-ha based land use economics are calculated to generate a NPV value for all identified land use types. In the opportunity cost analysis stage a land use change matrix has to be developed that reflect the historical land use change patterns and to which land use types forest have been converted. If there is no historical conversion of forest to other land uses opportunity costs do not appear and no opportunity cost curves can be generated.

Main outputs of processing the 1-ha economic models are Net Present Values (NPVs) as explained in the main report and land use related carbon stock changes. Based on this output all required input data for REDD ABACUS is generated and opportunity cost curves can be processed with ABACUS.

In the subsequent phase other REDD+ cost elements, namely institutional, implementation and transaction costs are estimated. While the transaction costs and implementation costs are derived from the project documents, institutional costs are calculated from a national average.

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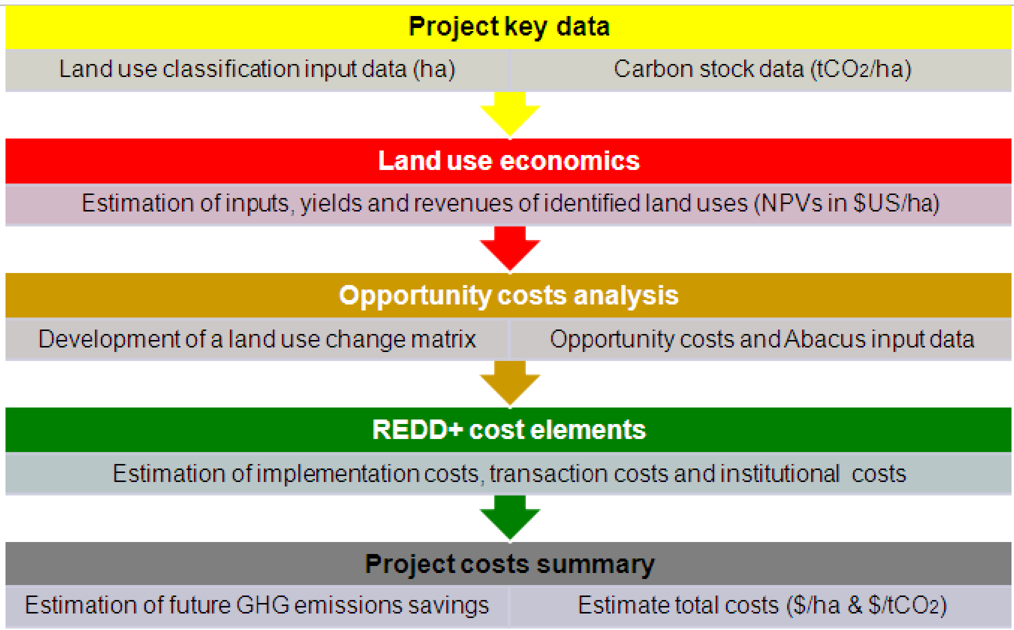
[13] http://www.worldagroforestry.org/sea/abacus

The model allows estimating all four REDD+ cost elements. Hence, indicating REDD+ costs for the envisaged emission savings by the project.

Figure 40: Methodology to estimate REDD+ cost elements



Project key area and carbon stock assumptions

For the TFCG Mjumita – Lindi project model we used input data from the project documents provided to the consultants and a project specific workshop in Dar es Salaam on 13 February 2012.

With regards to the drivers of deforestation, we used unsustainable charcoal production and shifting cultivation as the major drivers.

Table 52: Project area assumptions

Land use types of the project area (ha):	Historical land use on project area (ha)	At project start (ha)
Natural forest	93,800	76,992
Unsustainable charcoal production	0	8,404
Agriculture (Shifting cultivation)	0	8,404
Total	93,800	93,800

Carbon stock data of land use types

For the carbon stock data the long-term average carbon stocks shall be used. Based on provided data and our own estimates, the following carbon information was generated and used in our further calculations:

Table 53: Carbon stock assumptions

Land use types	**Carbon stocks (ABG, BGB) (tCO_2/ha)**	**Carbon stocks (ABG, BGB) (tC/ha)**
Natural forest	**158.6**	**43.3**
Unsustainable charcoal production	**53.8**	**14.7**
Agriculture (Shifting cultivation)	**53.8**	**14.7**

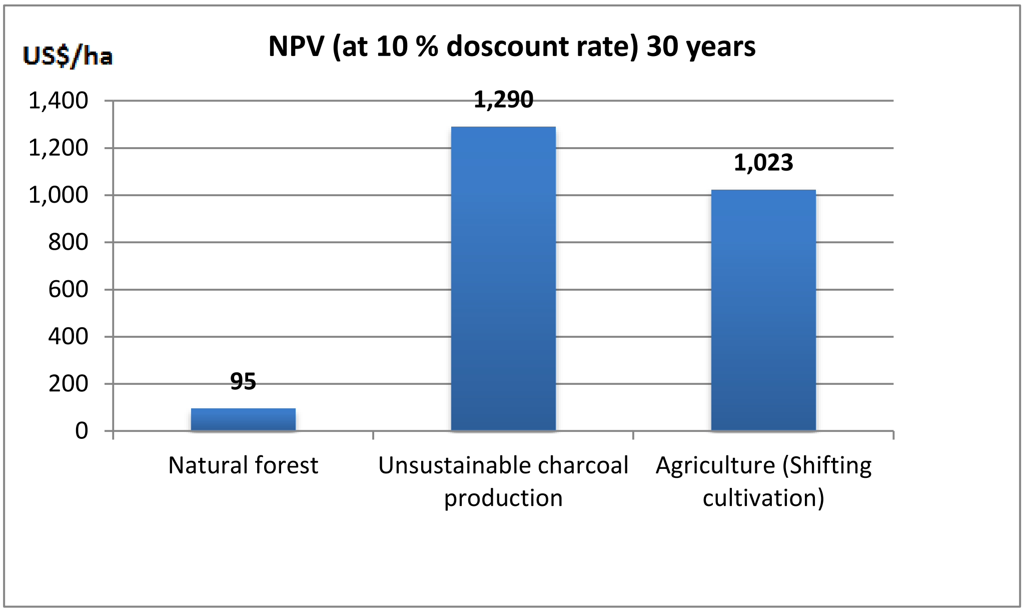
Note: The long-term average is based on the average aboveground and belowground carbon stock from TFCG Mjumita project staff derived from field surveys.

1-ha models for existing land use types

For the establishment of opportunity costs curves each identified land use type requires the establishment of a Net Present Value (NPV), an economic performance indicator that shows the profitability of a land use in US$/ha. For the NPV calculation we used a discount rate of 10 % and discounted the annual cost and revenues over a period of 30 years, equivalent to the project lifetime.

The figure below presents the NPVs for the identified land uses. All key assumptions made in these 1-ha models are detailed in Annex 1.

Figure 41: NPVs for the TFCG Mjumita – Lindi project



Land use change matrix

The land use change matrix is a key input for the opportunity cost analysis spreadsheet which is also used as an input table for ABACUS. It provides information about the land use change dynamics in the project area. In addition to providing data needed for the opportunity cost analysis, the land use change matrix can be used to assess the driving forces of deforestation and land use trajectories over time. The land use change matrix is normally based on the historical remote sensing analysis that compares land uses at two different points in time, e.g. 2001 and 2011.

Table 54: Land use change matrix for project (2001 – 2011) (ha) presents the estimated land use change matrix for the project case. The vertical column indicates the year of the initial land cover. The change to another land use is shown on the horizontal row. The diagonal of the table indicates unchanged land area units between two time series (in orange font). The figures in green font indicate the conversion of natural forest at an historical point in time to different other land use types, identified as the drivers of deforestation at the current point of time (e.g. at project start).

The total value at the end of the first row is the area in natural forest at the historical point of time (93,800 ha). The total value at the bottom of the second column is the total area in natural forest at project start (76,992 ha). Therefore the study area lost 16,808 ha of forest between 2001 and 2011.

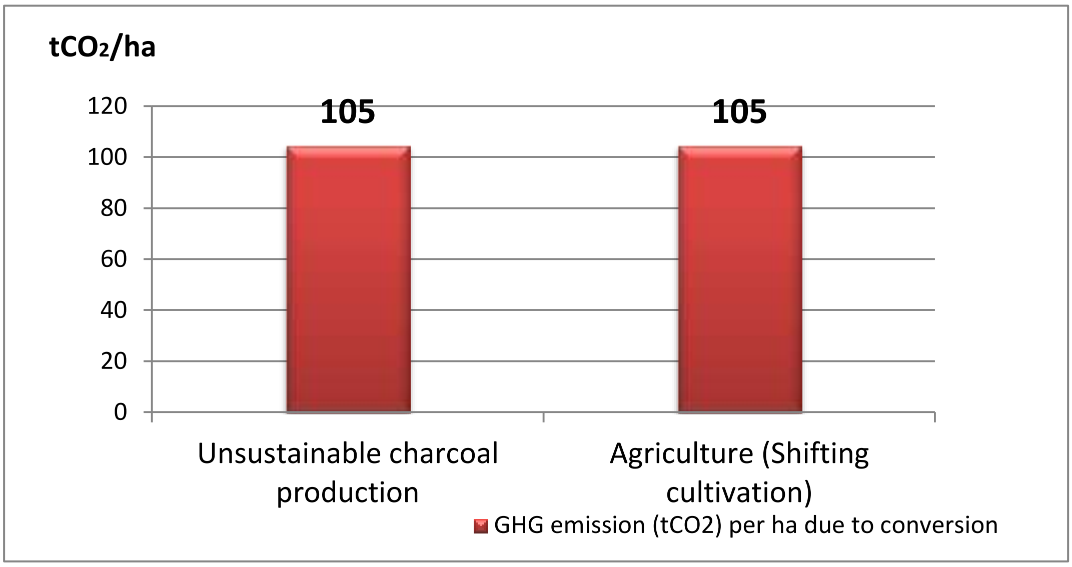
Table 54: Land use change matrix for project (2001 – 2011) (ha)

Initial (change from initial land cover) / Final (change to final stage/latest land cover classification) (ha)	Natural forest	Unsustainable charcoal production	Agriculture (Shifting cultivation)	Total
Natural forest	76,992	8,404	8,404	93,800
Unsustainable charcoal production		0		0
Agriculture (Shifting cultivation)			0	0
Total	76,992	8,404	8,404	93,800

Opportunity costs

The opportunity cost were calculated based on the following carbon stock losses (tCO_2/ha) from the conversion of natural forest to the respective land use types.

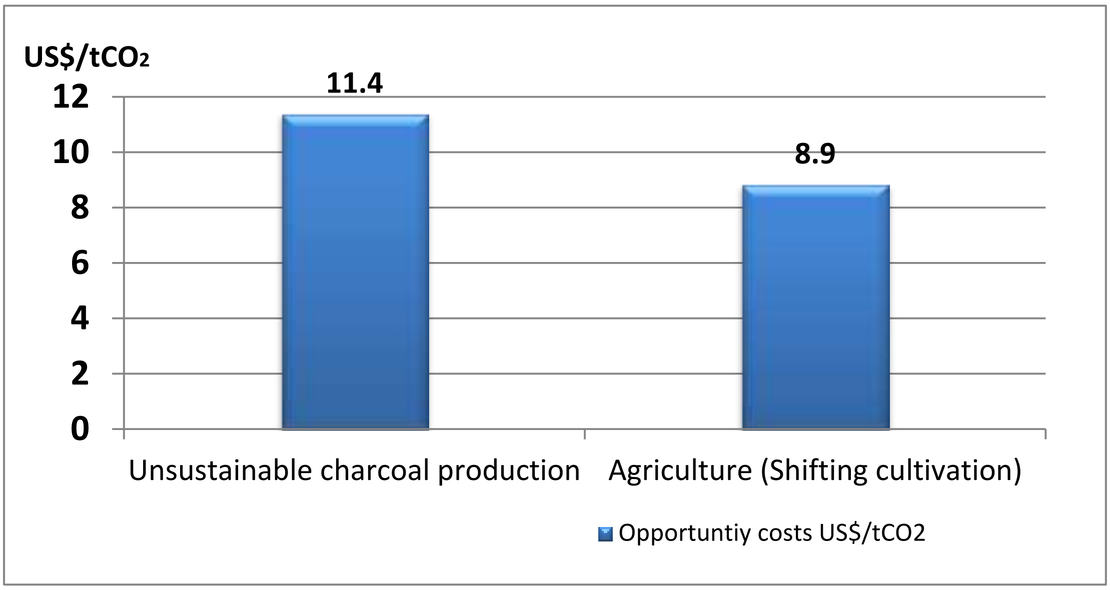
Figure 42: GHG emissions (tCO2/ha) from conversion of natural forest to other land use types in the TFCG – Mjumita Lindi project area



Using the NPV (and the respective carbon stock data, for each land use, the following opportunity costs (US$/t$CO_2$) were calculated by dividing the opportunity cost NPV (Figure 41) for the land use change by the related carbon stock change (Table 53) per ha.

In the TFCG Lindi project case the opportunity costs would range between US$ 11.4/tCO_2 for unsustainable charcoal production and subsequent shifting cultivation and US$ 8.9/tCO_2 for agriculture (shifting cultivation).Thus for shifting agriculture and unsustainable charcoal production, the NPV is higher than that of natural forest. Thus, opportunity costs are positive. The costs indicate, which monetary value will forgo the user, when not converting the forest.

Figure 43: Opportunity costs (US$/tCO2) from conversion of natural forest to other land use types in the TFCG Mjumita Lindi project

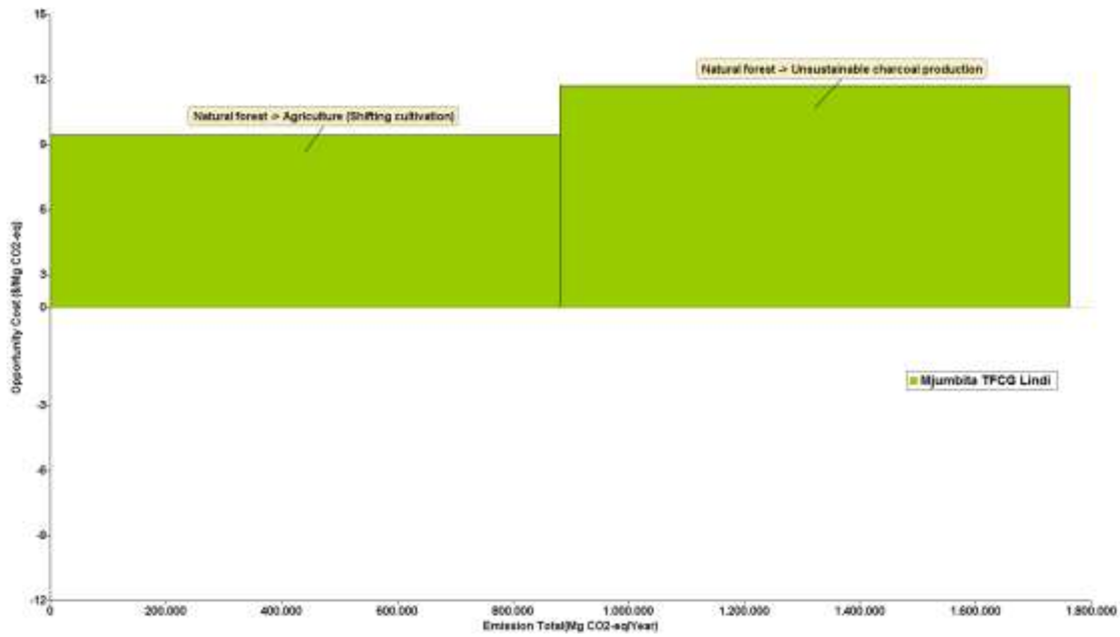


The described data (NPV and land use change matrix based carbon stock changes) constitute the key input data for the ABACUS software to generate the project`s opportunity cost curves.

An opportunity cost curve compares the quantity of potential emission reductions with their opportunity costs. The vertical y-axis represents the opportunity cost of the emissions reduction option (in US$ per tCO_2), while the horizontal axis depicts the corresponding quantity of reduction (in million tCO_2) at the respective price.

For the described land use change scenario (land use matrix) emissions of about 1.76 million tCO_2 would occur over a period of 10 years.

Figure 44: Opportunity cost curve TFCG Mjumita - Lindi project



Note: The GHG emissions in the cost curve occurred over a period of the last 10 years, as based on historical land use change indicated in the land use change matrix.

Building the REDD+ project case

The opportunity cost curves is based on historical data and land use dynamics. In order to estimate the complete REDD+ project cost elements, implementation costs, transaction costs and institutional costs need to be estimated. In our calculation we assume that opportunity costs will be compensated by the implementation activities, thus opportunity costs are not added up to total costs. For detailed explanation, refer to the main report.

Implementation costs are directly associated with actions to reduce deforestation and forest degradation. Examples include the costs of guarding a forest to prevent unsustainable charcoal production, replanting trees in degraded or logged forests, or intensifying agricultural land. Implementation may also comprise the training and capacity-building activities at the project level that are necessary to make the REDD+ programs happen.

For the implementation and transaction costs we used the annual project budget of the TFCG Mjumita project proposal financed by the Royal Norwegian Embassy Norway and assigned the respective cost the implementation and transaction cost categories.

Transactions costs are incurred throughout the process: certifying the project according to a carbon standard, transaction negotiation, monitoring, reporting, and verifying GHG emission reductions. Transaction costs are incurred by the implementers of a REDD+ program and third parties such as verifiers, certifiers, and lawyers.

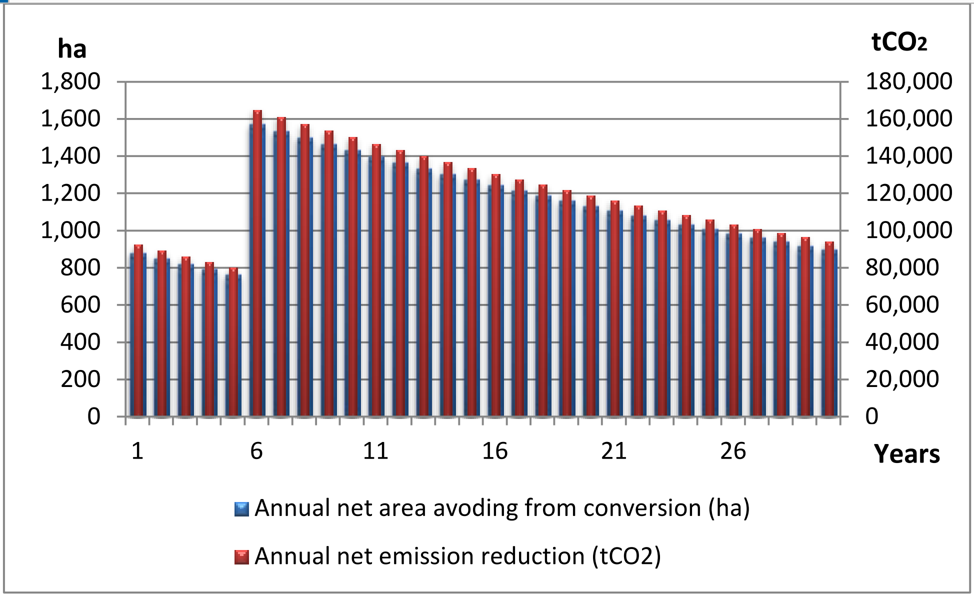
Institutional costs are related to public expenditures to build institutions and realize REDD+ at national scale. That includes governance structures, clarifications on land tenure issues, capacity building and extension services; policy formulation and law enforcement. The estimation of the institutional costs is based on a country wide average in US$/ha based on the total forested area in Tanzania and the budgets to build a national REDD+ framework.

In the following, we initially provide estimates on the projected GHG benefits due to REDD+ activities and subsequently provide cost estimates on implementation costs, transaction costs and institutional costs.

REDD+ related GHG benefits projections

Based on inputs from TFCG Mjumita project staff we estimated that the project will on average prevent 1,150 ha/yr of natural forest of being converted to other land uses equivalent to 120,000 tCO_2/yr, as shown in the figure below.

Figure 45: Avoided deforestation area and GHG benefits in project scenario



Implementation, Institutional and Transaction costs estimates

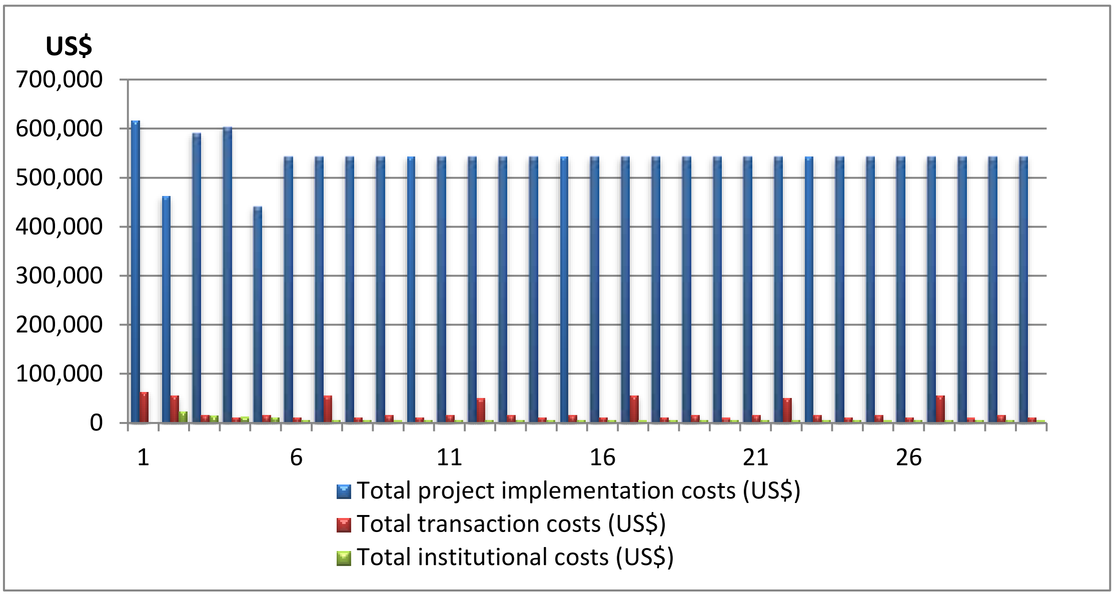
When implementing a REDD+ project, significant investments are required in order to cover the costs associated with actions to reduce deforestation, and hence emissions. All of these and similar measures incur up-front investment and perhaps recurring costs for public and/or the private sectors, which need to be adequately assessed and financed.

Based on the budget for the TFCG Mjumita Lindi and Kilosa project budget area cost estimates were provided for the initial 5 years of the project lifetime. Based on these estimates we extrapolated the costs of the project for the subsequent 25 years.

In total, implementation costs are estimated at an annual average of US$ 0.55 million for the project area (US$ 16.35 million over 30 years)[14]; transaction cost are estimated at an average of US$ 25,000 annually (US$ 0.75 million over 30 years); and institutional costs will amount at US$ 8,500 (US$ 0.27 million over 30 years). For a detailed cost breakdown, see the Excel-based tool to estimate REDD+ cost elements.

[14] Not taking into account inflation.

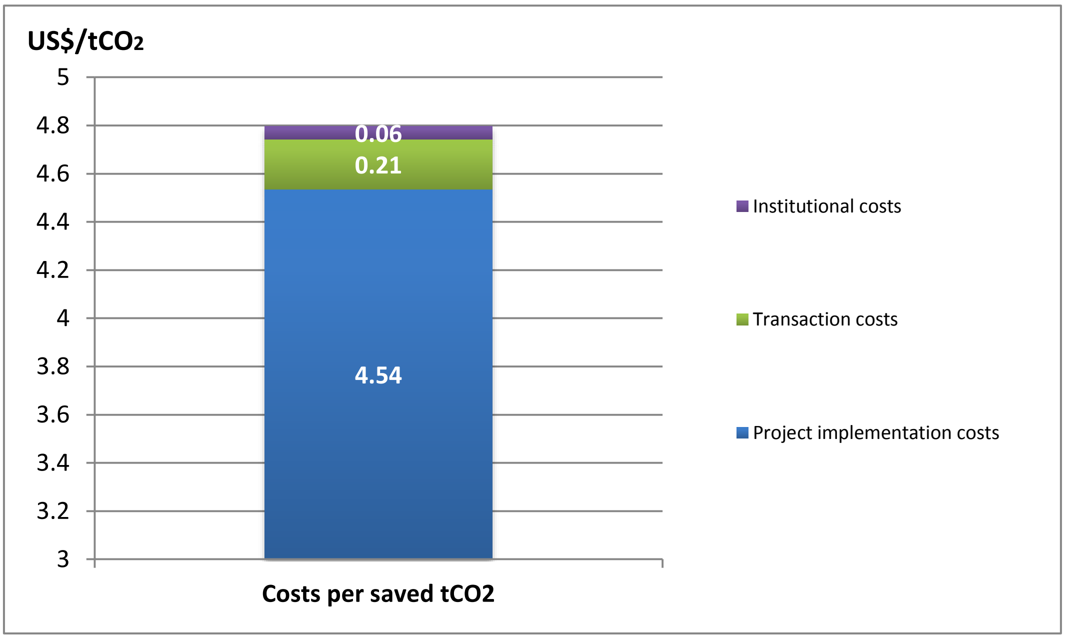
Figure 46: Annual implementation, transaction and institutional cost estimates (US$)



REDD+ costs per saved tCO_2

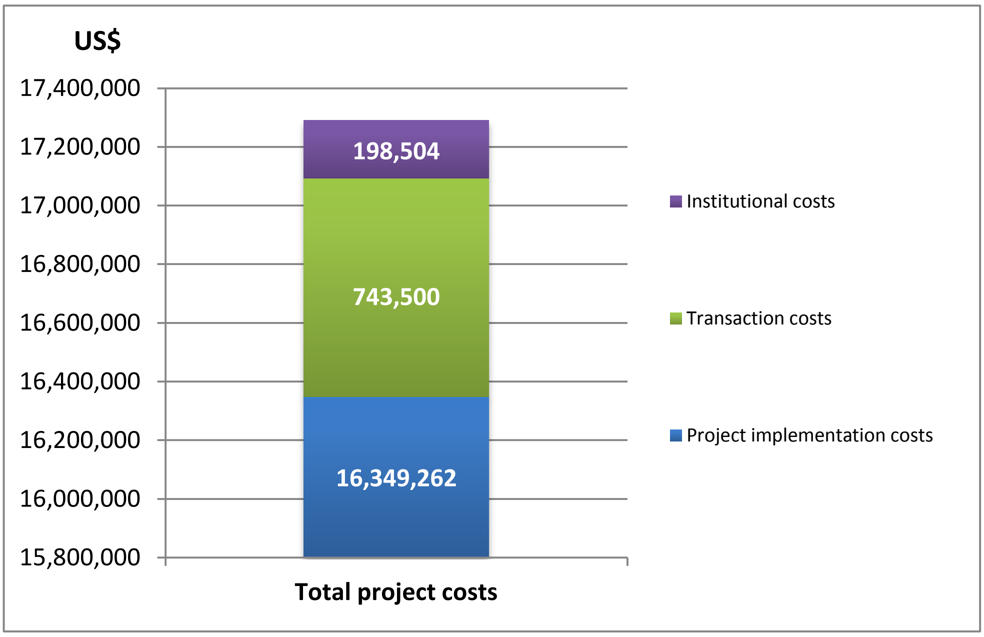
In the TFCG Mjumita Lindi project a total a price of US$ 4.8 per conserved tCO_2 would be required in order to cover, implementation (US$ 4.5/tCO_2), transaction (US$ 0.2/tCO_2) and institutional costs (US$ 0.1/tCO_2).

Figure 47: REDD+ costs per saved tCO2 (US$)



On the entire project scale and in order to avoid 3.6 million tCO_2 emissions, the costs would add up to about US$ 17.3 million over a project lifetime of 30 years.

Figure 48: Total project costs TFCG Mjumita Lindi (US$)



Key assumption of 1-ha based land use economics

Natural forest

For the natural forest we assume that forest is used extensively for the collection of fuel wood and non-timber forest products in a sustainable manner.

Table 55: Natural forest assumptions (1 ha)

Annual costs	Quantity	Unit	Price per Unit	Quantity	Unit
Annual labour costs fuelwood collection	15	days/ha/yr	2	30	US$
Annual labour costs NTFP collection	15	days/ha/yr	2	30	US$
Annual cost small-scale timber extraction					
Harvesting	0	US$/$m^3$		0	US$
Timber transportation	0	US$/$m^3$		0	US$
Milling	0	US$/$m^3$		0	US$
Total costs				60	US$
Yields and Prices	**Quantity**	**Unit**	**Price per Unit**	**Quantity**	**Unit**
Annual fuel wood collection	1,5	m^3	20	30	US$
Annual NTFP collection	10	Units	4	40	US$
Annual small-holder timber extraction revenues					
Annual timber extraction volume	0	m^3/ha/yr			
Waste	0%				
Quantity sold	0,0	m^3/ha/yr			
Price	0	US$/$m^3$		0	US$
Total revenues				70	US$

Source: Authors estimates

Unsustainable charcoal production

In this scenario we assume that unsustainable charcoal production takes place over a period of 1 year, and subsequently converted to shifting cultivation for the remaining 29 years.

Table 56: Unsustainable charcoal production assumptions (1 ha)

Key parameters	Value	Unit	Source			
Years of charcoal production on a ha until clearance	3	Years	Authors estimates			
Alternative land use after clearance	Conventional agriculture (Shifting cultivation)					
Average aboveground biomass in year 0	36,8	tdm/ha	WWF, Malimbwi, Zahabu 2007			
Annual average biomass increment	2,4	tdm/ha	WWF, Malimbwi, Zahabu 2007			
Total commercially available biomass	44	tdm/ha				
Total annual commercially available biomass	14,7	tdm/ha/yr				
Average kiln efficiency	28%		Drivers of Deforestation in Kilwa Excel sheet			
Total annual commercially available charcoal	4,1					
Inputs for charcoal production	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Labour input (harvesting and charcoal making)	112	days/ha/yr	2	224	US$	Calculated from data in WWF, Malimbwi, Zahabu 2007

Tools and equipment	0	Units	0	0	US$	
Total cost charcoal production				224	US$	
Income	Quantity	Unit	Price per unit	Revenues	Unit	Source
Annual charcoal production	4,1	t/ha/yr	100	411	US$	Calculated from data in WWF, Malimbwi, Zahabu 2007
Total income charcoal				411	US$	

Agriculture (shifting cultivation)

As one of the major drivers of deforestation in the project area shifting cultivation is commonly practiced. For the determination of the NPV shifting cultivation, we used sesame as the sole crop which is the most profitable cropping system in the project region. This is due to the lack of data on the mix of cropping systems. Thus the opportunity costs are likely to be overestimated as other less profitable crops are grown.

Table 57: Mix of cropping systems (agriculture shifting cultivation)

Land use distribution for subsistence agriculture	% of total of land use
Activity 1: Sesame	100%

In addition we assume a land use cycle of 2 years of cultivation and 10 years of fallow which is consistently repeated over a period of 30 years. For the sesame cropping system, we developed a 1-ha model as shown below, that estimates the cost and revenues at the farm-gate level.

Table 58: Sesame production system key assumptions (1-ha)

Inputs at establishment (year 0)	Quantity	Unit	Price per unit	Costs	Unit	
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liters	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr/ha	94	days	1,5	141	US$	Business outlook Mjumita TFCG REDD
Total cost establishment				141		
Inputs at management (from year 1 onwards)	**Quantity**	**Unit**	**Price per unit**	**Costs**	**Unit**	**Source**
Seed	0	kg	0	0	US$	
Fertilizer	0	kg	0	0	US$	
Herbicides	0	liters	0	0	US$	
Insecticides	0	liter	0	0	US$	
Tools	0	Units	0	0	US$	
Machinery	0	days	0	0	US$	
Labour input/yr	94	days	1,5	141	US$	Business outlook Mjumita TFCG REDD
Total cost management				141	US$	
Income	**Quantity**	**Unit**	**Price per unit**	**Revenues**	**Unit**	**Source**

Yields /ha/yr	741	kg/ha/yr	0,75	556	US$	Business outlook Mjumita TFCG REDD
Yield start after establishment:	1	Years				
Total income				556	US$	