CARBON FINANCE AND REFORESTATION: A SURVEY OF AFRICAN CASES

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Thesis presented in partial fulfillment of the requirements for the Master's degree of Sustainable Development and Management in Public Management and Planning at the University of Stellenbosch

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DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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ABSTRACT

This thesis addresses the topic of carbon finance in the context of reforestation and avoided deforestation. The research is based on the Nhambita Reduced Emissions from Deforestation and Degradation (REDD) and Agro-forestry carbon offset project in North West Mozambique. The thesis raises important questions in terms of the relevance of carbon offset projects to human and biophysical realities in Africa. The research was conducted through the lens of ethnographic development and explores how carbon offset projects are received by recipient communities. What issues do such projects attempt to address? Are the targeted issues the 'real' issues, as they are perceived by local populations in developing countries? Who do such projects benefit and who do they benefit the most?

The thesis comprises two academic papers. The first paper is a synthesis article presenting a review of key issues with regards to the roll-out of improved cooking stoves (ICS) in the context of carbon offset projects, combined with a pre-feasibility study on the introduction of ICS in the Nhambita village. It shows how biomass will continue to play a dominant role in addressing Southern African energy needs and how a large scale dissemination of ICS could play a seminal role in alleviating pressure on threatened ecosystems. The paper, however, recognizes that ICS programmes are not a panacea and discusses the pitfalls of paradigms underlying stove-provision programmes to date. Based on a review of the pertinent literature and on the field work conducted in Mozambique, conclusions are drawn that environmental and health considerations do not constitute a sufficient 'pull' factor from the end user's perspective. It appears that best channels to engage with the targeted users are economic and social rationales. This debate is of particular

relevance to climate change policy but it also offers insights in terms of the acceptance of such programmes by the target communities.

The second paper is related to the first in that it discusses the opportunities and challenges associated with the developmental ambitions of carbon offset projects. By virtue of the market systems that regulate them, such carbon offset projects imply an innovative developmental praxis, whereby project recipients become the owners and the sellers of a tangible good in the form of carbon credits. This innovative dimension is, however, thwarted by the fact that such projects stir welfare expectations from project participants. Such livelihood improvement expectations become the fertile ground for difficulties reminiscent of the weakness of traditional aid. The intricacies underpinning this new mechanism that combines land use changes with environmental conservation and livelihood benefits are debated in the context of private entrepreneurship and global markets. The analysis is anchored in a socio-anthropological interpretation of climate change science and lays the emphasis on the risks and constraints of such projects, from the perspective of the target communities. The paper concludes by discussing the policy implications of these findings.

OPSOMMING

Hierdie tesis behandel die onderwerp van koolstoffinansies binne die konteks van herbebossing en vermyde ontbossing. Die navorsing is gebaseer op die Nhambita Veminderde Emissies van Ontbossing en Degradasie (REDD) en die agrobosbou koolstofkompensasieprojek in Noord-Wes Mosambiek Die tesis opper belangrike vrae ingevolge die relevansie van koolstofverminderingsprojekte vir die menslike en biofisiese realiteite van Afrika. Watter kwessies probeer sulke projekte aanspreek? Is die geteikende kwessies die ‘ware’ kwessies, soos hulle gesien word deur plaaslike bevolkings in ontwikkelende lande? Wie trek voordeel uit sulke projekte en wie trek die meeste voordeel daaruit?

Die tesis behels twee akademiese verhandelings. Die eerste verhandeling is ‘n sinteseartikel wat ‘n oorsig bied van sleutelkwessies ten opsigte van die uitrol van verbeterde kookstowe (VKS) binne die konteks van koolstofverminderingsprojekte, gekombineer met ‘n vooruitvoerbaarheidstudie oor die bekendstelling van VKS in die Nhambita-dorpie. Dit dui aan hoe biomassa sal voortgaan om ‘n dominante rol te vervul in die aanspreek van energiebehoeftes in Afrika en hoe die onderliggende paradigmas van vorige stoofvoorsieningsprogramme heroorweeg moet word om tot die debat by te dra. Hierdie benadering erken die belangrikheid van hierdie hernubare energiebron, terwyl dit die ekologiese implikasies van die swaar steun op biomassa besef, veral in Suider Afrika. Gebaseer op 'n oorsig van gepaste literatuur sowel as die veldwerk gedoen in Mosambiek, word die gevolgtrekking gemaak dat omgewings- en gesondheidsoorwegings nie genoeg stukrag verleen vanuit die eindgebruiker se perspektief nie. Die beste kanale om by die teikengebruikers betrokke te raak, is ekonomiese en sosiale rasionale. Hierdie debat is van besondere betekenis vir die

klimaatsveranderingsbeleid maar word ook fyn bestudeer ten opsigte van die aanvaarding van sodanige programme deur die teikengemeenskappe.

Die tweede verhandeling is verwant aan die eerste in die opsig dat dit die geleenthede en uitdagings bespreek wat verband hou met die ontwikkelingsbehoeftes van koolstofverminderingsprojekte. Uit hoofde van die markstelsel wat hulle reguleer, impliseer sulke koolstofverminderingsprojekte ‘n innoverende ontwikkelingspraktyk, waarvolgens projekontvangers die verkopers word van ‘n tasbare voordeel in die vorm van koolstofkrediete. Hierdie innoverende dimensie word gedwarsboom deur ‘n tradisionele benadering tot ontwikkeling wat ontstaan uit die welvaartverwagtings van projekdeelnemers. Sodanige bestaansverbeteringverwagtings word die teelaarde van probleme kenmerkend van die swakheid van tradisionele bystand. Die ingewikkeldhede van hierdie nuwe meganisme, wat landgebruikveranderings kombineer met omgewingsbewaring, asook die bestaansvoordele word gedebatteer binne die konteks van privaat entrepreneurskap en wêreldmarkte. Die ontleding is geanker in ‘n sosio-antropologiese interpretasie van klimaatsveranderingwetenskap en benadruk die risiko’s en beperkings van sulke projekte, vanuit die perspektief van die teikengemeenskappe.

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My field research would have not borne any fruit without the support of Namo and Regina, who not only assisted me with their translation skills when conducting interviews, but who also shared their valuable insights on the Nhambita community. I have fond memories of our walks and cycles through the villages of Nhambita, Munhanganha and Boe Maria. I also thank Clement for his assistance in translation and to Petro Blanc and to David Alheit for grand conversations. My mentor in Nhambita was Gary Gooseman; a man of many talents with a heart of gold and who formally introduced me to the *Regulo*, for me to get permission to undertake my research. Thank you for initiating me to the inner secrets of the *Comunidade* and for sharing historical moments with me. The beehive I imported from Nhambita was put up in your name.

Thank you to my parents for being the pillars of my life and for always being supportive of my endeavours, no matter how unconventional they may be. My fondest gratitude goes to Matthew Mentz, whose inspired and uncompromising skepticism always encourages me to scratch below the surface. Thank you for the greatest common adventure and for keeping the inner creature alive through our kin's domain.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

AFOLU	Forestry and Other Land Use Projects
BC	Black Carbon
BOP	Bottom of the Pyramid
CDM	Clean Development Mechanism
CAR	Certified Emission Reduction
CPR	Common Pool Resources
DFID	United Kingdom Department for International Development
DIE	German Development Institute, from the German *Deutsches Institut für Entwicklungspolitik.*
DME	Department of Minerals and Energy (South Africa)
DNA	Designated National Authority
DWAF	Department of Water Affairs and Forestry (South Africa)
FCPF	Forest Carbon Partnership Facility
FDI	Foreign Direct Investments
FRELIMO	Liberation Front of Mozambique, from the Portuguese *Frente de Libertação de Moçambique.*
GDP	Gross Domestic Product
HDI	Human Development Index
IAP	Indoor Air Pollution
ICRAF	World Agro-forestry Centre
ICS	Improved Cooking Stove
IPCC	Inter-governmental Panel on Climate Change
IMF	International Monetary Fund
FBAE	Free Basic Alternative Energy (South Africa)

GS	Gold Standard
LDC	Least Developed Country
MDG	Millennium Development Goals
OA	Official Aid
ODA	Official Development Aid
OECD	Organization for Economic Co-operation and Development
p.a.	per annum
p.c.	per capita
PDD	Project Design Document
PES	Payment for Ecosystems Services
PRA	Participatory Rural Appraisal
ProBec	Programme for Basic Energy and Conservation
tCO_2	Tone equivalent Carbon
TNMOC	Total Non Methane Organic Compounds
TSPs	Total Suspended Particulates
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary Carbon Standard
VER	Voluntary Emissions Reduction
REDD	Reduced Emissions from Avoided Deforestation and Degradation
WB	World Bank
WHO	World Health Organization

LEXICON

The Gold Standard

The Gold Standard is a non-profit foundation which aim is to develop independently audited methodologies for carbon projects. The standard is regarded as a high quality standard and carbon credits often fetch a premium price on carbon markets.

The Project

This term refers to the Nhambita agro-forestry and carbon offset project, located in the buffer zone of the Gorongoza National Park, Mozambique. This terminology follows that adopted on the ground by the Envirotrade team that manages the carbon offset project and by the communities living around the project. The project is commonly referred to as the 'Nhambita pilot project', which is a misleading appellation, since the *Regulado* (the administrative authority inherited from the colonial administration) counts ten different settlements. The Nhambita village just happens to be the settlement where the *Regulo*, head of the *Regulado*, lives (Sera, 2009). My research was completed in three distinct settlements, namely: Nhambita, Munhanganha and Boe Maria. When the terms 'Nhambita project' or 'Project' are used in the thesis, they therefore refer to the three above mentioned villages.

Plan Vivo

This is the name of the voluntary standard adopted to validate and commercialise the carbon offsets resulting from the agro-forestry project activities. The first *Plan Vivo* Project known as *Scolel Té* was started in 1997 in Mexico by the Edinburgh Centre for Carbon Management, together with the University of Edinburgh, both of which also partner with Envirotrade for the *Plan Vivo* project in Nhambita. The *Plan Vivo*

carbon management scheme is a normative system which validates the carbon credits generated through the project activities and then sells *Plan Vivo* Certificates to buyers in the Northern Hemisphere.

Machamba

This is the Portuguese term to designate an agricultural field. In Mozambique, all land legally belongs to the state and there is therefore no formal land tenure system. Any person wanting to 'open a *Machamba*' would ask permission to the local administrator, the *Regulo* or to the person who reports back to him, the *Mfumo* (Jindal, 2004).

REDD

Means 'Reduced Emissions from Avoided Deforestation and Degradation'. REDD is a programme aimed at curbing greenhouse gas (GHGs) emissions resulting from activities leading to deforestation and forest degradation in developing countries. The REDD concept emerged from the thirteenth Conference of the Parties in Bali in 2007.

REDD+

When REDD was first conceptualized under the 2007 Bali Action Plan, provision was also made to include three additional activities, namely: conservation, sustainable forest management and enhanced carbon forest stocks. These were then merely seen as co-benefits of avoided deforestation and deforestation. However, the text that emanated out of the fifteenth Conference of the Parties in Denmark in December 2009 recognized these five elements on an equal basis and REDD thus became REDD+ (Centre for People and Forests: 2010, 6).

Regulado

Means the administrative authority inherited from the Portuguese colonial administration.

LIST OF TABLES

Research Methodology

Paper 1

Paper 2

Annexure

LIST OF FIGURES

Research Methodology

Paper 2

Annexure

LIST OF MAPS

Research Methodology

Annexure

LIST OF PHOTOS

Research Methodologies

Annexure

1. INTRODUCTION

To fulfill the requirements of the Master of Sustainable Development, Planning and Management, I have selected the research component consisting of two academic papers. The titles of the two papers are as follow:

Paper 1: Can improved wood based cooking stoves modernise the use of biomass in Southern Africa and reduce CO_2 emissions? *Opportunities and risks of carbon offset stove programmes with reference to the Nhambita test case in Mozambique.*

It is proposed that this paper be submitted for publication to the *Climate Policy Journal.*

Paper 2: Do carbon offset projects present a new dimension to the development aid paradigm? *A critical assessment with specific reference to the Nhambita REDD and Agro-forestry carbon offset project, Mozambique.*

It is proposed that this paper be submitted for publication to the *African Development Review Journal.*

The papers use the Nhambita project, an agro-forestry based reforestation and avoided deforestation and degradation (REDD) project certified under the *Plan Vivo* standard (see Lexicon) located in North-West Mozambique, as a concrete reference point to anchor the discussion.

The first paper falls within a collaborative agreement between the German Development Institute (*Deutsches Institut für Entwicklungspolitik* – DIE) and the Programme for Basic Energy and Conservation (ProBec), the representatives of which I met during the initial stage of my research. ProBec had agreed to donate 21

‘StoveTec’ stoves for the purpose of my field research, partly aimed at assessing the feasibility of developing a stove carbon offset project within Nhambita. The first stage of this pre-feasibility study was completed during the field research; my research for the first paper focuses on the implications, risks and opportunities associated with the dissemination of efficient wood stove projects in Southern Africa. It was suggested that this paper could constitute a preliminary discussion paper for a workshop to be held at the DIE in Bonn, Germany, in April 2010.

The second paper is related to the first paper in that it investigates whether the developmental endeavour of renewable energy and land use change carbon offset projects bring a new dimension to decades of developmental aid. Informal discussions were held with the DIE to make this paper, on an *ad hoc* basis, the object of a co-paper to be written between the Stellenbosch University and the DIE. I spent two weeks during November 2009 at the DIE, to finalise aspects of this paper, thanks to the multi-sectoral input of the research team at the DIE.

Both papers use the agro-forestry and avoided deforestation project rolled out in Nhambita, Mozambique, as a case study. The visit was completed during the month of June 2009 for the purpose of the Master in Sustainable Development, Planning and Management and originally consisted of testing the feasibility of introducing efficient wood stoves to the area as part of a carbon offset project. The project is still in its infancy but provided me with insights to the above mentioned problem statements.

For the purpose of my research, I have identified three settlements within the Nhambita project, namely: Nhambita, Munhanganha and Boe Maria. The papers attempt, where relevant, to undertake a critical assessment of the problem areas outlined in the abstract, through a ‘dialogue’ between the literature and the ground

truthing field work undertaken in the Nhambita project. The intent of this piece of applied research is to provide a useful resource for academics, developmental practitioners and the parties associated with the Nhambita project.

2. RESEARCH METHODOLOGY

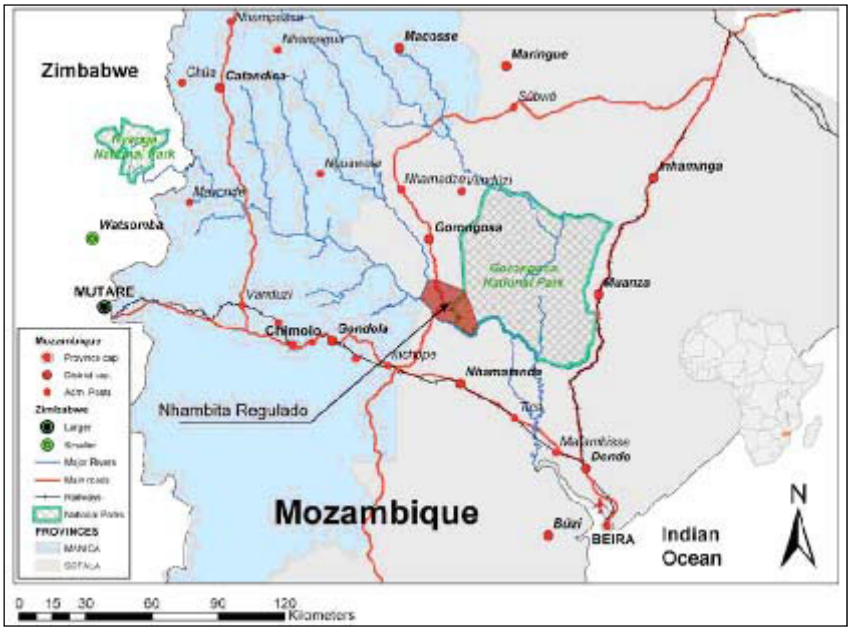
In this methodological section, I first present the project area that was the object of field research. I then introduce the context and rationale to the papers and the methodological approach and tools that I have adopted to respond to the research questions. The challenges encountered and the limitations of the research undertaken are then discussed.

2.1 Project description

2.1.1 Project area

The project area, commonly referred to as the 'Nhambita pilot project', is located within the Chicale *Regulado*, in the Sofala Province, Mozambique, which spans approximately 20,000 hectares (Envirotrade, 2008). The project is located in the buffer area of the Gorongoza national Park (maps 1 and 2). The Nhambita communal land counts ten settlements totalling about 6,500 inhabitants, over a surface area of 348 m². In their population modelling, Tipper and Grace (2008) mention a total population affected by project activities amounting to 5,263 people and distributed over 55,605 ha. This figure slightly differs from the 6,449 inhabitants over the ten settlements of the area, reported in the mini-census carried out by Envirotrade (2008).

My field research focused on three of the Nhambita communal settlements, namely Nhambita, Boe Maria (both featured on map 3) and Munhanganha, which is not featured on map 3 and which lies between Nhambita and Boe Maria.

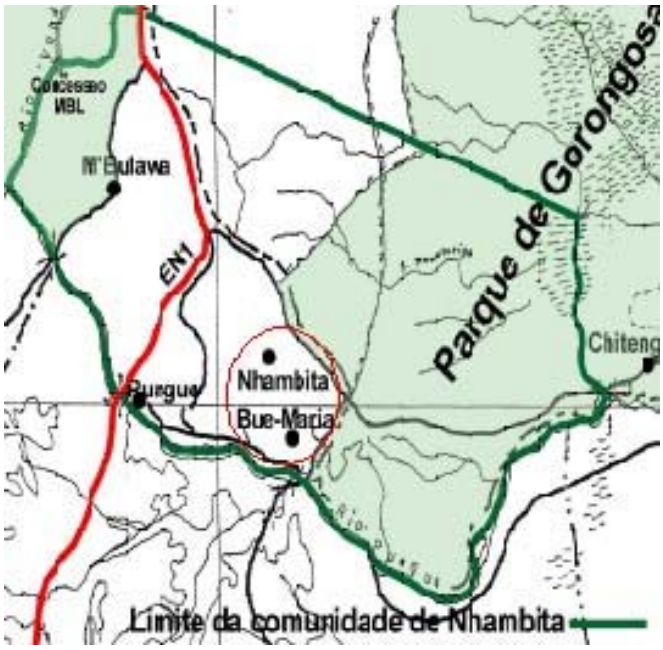


Map 1: Regional map

Source: GIS data from Aro Center

Map 2: Project area map

Source: Sambane, 2005, as cited in Envirotrade (2008).



Map 3: Project area map showing the location of the field research

Source: Envirotrade, 2008

2.1.2 Project activities

The Nhambita project is the result of a partnership initiated in 2003 between the private UK-based company, Envirotrade, which implements the project on the ground, the University of Edinburgh and the Edinburgh School of Management, with original contributions from the World Agro-forestry Centre (ICRAF). The project addresses the interwoven imperative defined as Adaptation and Mitigation in the context of Sustainable Development (Bizikova, Robinson and Cohen, 2007) by combining mitigation in the form of the REDD activities with adaptation through agro-forestry activities.

The greatest proportion of the Nhambita project's carbon offset activities stem from the REDD project which consists of protecting a total of 11,071 ha of Miombo forest

that fall under the jurisdiction of the Nhambita community in the buffer area of the Gorongoza National Park (Jindal, 2010). “The project team estimates that these protection and conservation activities have reduced emissions at the rate of 7.33 tCO_2/ha per annum since 2006, generating a total of 154,457 tCO_2 as REDD offsets” (Jindal, 2010:7).

This REDD component is complemented by the agro-forestry portfolio of activities, the purpose of which is to curb the loss of soil fertility in agricultural fields (*Machambas*) through the planting of green manuring trees and fruit trees for subsistence and commercial purposes. Income received through the *Plan Vivo* standard (Plan Vivo, 2008) mitigates the effects of the loss of soil fertility and resulting decrease in food production by allowing villagers to buy food in months of food shortages. In May 2008, the project included 1,234 agro-forestry contracts in the form of border planting, the planting of fruit trees in home yards and the planting of fruit orchards, over a total surface area of 1,000 ha of land (Jindal, 2010:7). This represented in 2007 a total of 500,000 trees planted as part of project activities (Grace, 2007), amounting to 82,056 tCO_2 offsets.

These two sets of activities are complemented by small micro-enterprises such as bee keeping, tree nurseries and a carpentry workshop. The project also has a research component managed by the Edinburgh University and the Envirotrade personnel (Jindal, 2010).

The business model adopted for the project is that of a formal business venture and it aims to “demonstrat(ing) the environmental, economic and social benefits that can be delivered by implementing a 'best practice' business-enterprise” (Envirotrade, undated).

For detailed literature on the project, see the documents downloadable from http://www.envirotrade.co.uk/html/resources.php, with specific reference to the European Union Final reports.

2.2 Rationale for the papers

What is meant by 'development' is often contentious, with mainstream economics contending that material accumulation is the most valuable indicator of improved living conditions, as testified by the adoption of the Gross Domestic Product (GDP) index in the aftermath of the Second World War. The increasing role played by the Human Development Index (HDI) in the 1990s epitomized the growing rising awareness of non materialistic needs (Dresner, 2002), whilst other schools of thought put forward intangible indicators, such as happiness and well-being (Macy & Young Brown, 1998), as indexes of development.

I would argue that development consisting of 'hand-outs' and promises of monetary flows is possibly the most harmful way of assisting emerging nations, in that it undermines sovereignty and cripples the vital energies of entrepreneurship. Any intervention solely aimed at improving the welfare of human beings is vain, if the natural resources on which humans depend are degraded. Development interventions should therefore always aim at enabling communities to manage their local environment sustainably. The question that then arises is: what is a better way of assisting emerging nations improve the quality of life of their people and the health of their natural surroundings?

The principle of Payment for Ecosystem Services (PES), under which carbon offset markets fall, constitutes a promising new developmental paradigm, since the financial

flows of this market can benefit Southern nations and because the recognition of Nature's laws becomes a bargaining power.

But a few questions remain: how many short-sighted assumptions are we making when advocating for PES in tackling poverty and environmental injustice? Are we not yet again projecting ethno-centrist ideals on those whom these markets are addressed to? Are we not exporting concepts and perceptions which we assume will be heartedly embraced, without envisaging the harm they could possibly do to the social fabric of communities? How can we be so certain that it will benefit those they target and those recipients communities will unconditional embrace them? These questions are important, since the way any new concept (PES) or object (such as ICS, in the case of these papers) are received, ultimately conditions the success of developmental endeavours.

In the first paper, I have used the study of an ICS project as an entry point to this debate, with the departing assumption that this technology can potentially improve the living conditions of users, whilst contributing to preserving threatened ecosystems. The questions I ask in the first paper pertain to whether the arguments articulated by the 'developers' to promote ICS, actually resonate with the recipients, 'objects of development' (Moss, 2005). In the discrepancy between those perceptions lies the risk of potential project failure. What is required for a successful, ‘win-win’ ICS dissemination project?

The second paper in turns questions the rationale of carbon offset projects from the perspective of the target communities. What is the benefit of such projects to them? How does the rehabilitation of degraded ecosystem translate on the ground? How do

those coming on the ground to implement those theoretical ideas interact with communities and how does this relationship impact on project delivery?

From a methodological perspective, the purpose of my field research was threefold. My research focused on:

i) Getting a preliminary understanding of energy consumption patterns and cooking regimes of people living in rural villages close to a forest area. This first part was aimed at preparing the ground for:

ii) The introduction of efficient wood-burning StoveTec stoves donated by ProBec in order to test the preliminary social response of villagers to this new technology. These two primary goals were complemented by:

iii) Engagements with villagers aimed at uncovering communal and individual responses to the carbon offset project.

Field work spanned over 33 days, from 28 May to 30 June 2009. Due to time constraints and logistical difficulties, the findings of this research remain limited. The field work will be merely used in this paper as anecdotal evidence, in order to illustrate the literature on the topic and ground the discussion in an empirical case study.

2.3 Research approach

The study of the project area was divided into two steps (see Figure 1). Firstly, my primary research consisted of a literature review on the project, combined with experts' interviews. My secondary research entailed assessing the energy and wood consumption baseline in the research area (n=40) (Figure 1).

- 25 March- 20 May 2009: Primary research: literature review, identification of research sites, experts' interviews.
- 25th May-9th June 2009: Start of secondary research: Energy baseline (n=40) and socio-economic baseline of target households (n=20)
- 11th June 2009: Introduction of Improved Cooking Stoves (ICS)
- 20th -25th June 2009: Preliminary assessment of social response to ICS

Figure 1: Research Schedule overview and time line

Source: Compiled by the author

2.3.1 Primary research

The literature I have engaged with for the first paper essentially focused on the fields of energy, forestry, biomass consumption, innovative development practices and ICS. I discussed these topics with several practitioners and have conducted experts' interviews to better understand ICS dissemination challenges and opportunities on the ground.

The second paper is grounded in literature pertaining to PES, REDD and development science, with a specific focus on communal and social responses to development interventions. This later aspect can be referred to as 'ethnographic development' (Moss, 2005; Easterly, 2006); this approach offered a lens through which the research was conducted and a way of testing the legitimacy of development praxis from the perspective of the community. Over and above the conventional literature, the second paper makes use of extensive 'grey' literature. The reason for this is that the views of people affected by carbon offset projects are rarely reported in formal papers. Interviews and workshop reports constitute platforms where the voices of indigenous

and local communities can be heard and they offer valuable contributions to this discussion. I took part in a REDD workshop in Cape Town (February 2009) and one in Libreville, Gabon (October 2009), which provided me with valuable insights in this respect.

2.3.2 Secondary research

The field research was conducted with 40 randomly selected households (explained in section 2.2.4). 20 households, referred to as the 'target group', were then selected to be part of the stove pilot programme, on the ground of advice given by Envirotrade team members and with the intent of being as representative as possible of socio-economic variables and of kitchen regimes. This implied that this group was inclusive of both affluent and poor households, dual and single headed households, individuals who were employed and others who only practiced subsistence farming and households which cooked with firewood and others with charcoal. Once the target group had been selected (n=20), I conducted research to define the socio-economic baseline in these households.

My intention when defining the target group was also to identify households that had proven sufficiently cooperative in allowing time for my research, in anticipation that these same households would be requested to devolve further time to follow-up research. The 20 other households that were not selected to be part of the stove pilot programme are referred to as the 'control group'. The function of the control group is to permit potential changes of wood consumption behaviours in the target group to be measured against the original baseline.

It was originally planned that the stoves would be delivered after two weeks of completing this baseline survey, but the stoves arrived two weeks later than planned

which gave me only a week within which to test the social response to the stoves. Households that were presented with a stove were also given a two hour training session, dealing with the causes of global warming, the contribution that efficient stoves could make to mitigating GHG emissions[1] and the usage of the stove and its health benefits. During this presentation, I followed the instructions outlined in the manual prepared by StoveTec (StoveTec, undated – annex 2) to explain how to use the stove. I then explained to households members that they had five days (instead of the original 15 days originally planned) to decide whether or not they wanted to purchase the stove at the price of 200 Meticaes (equivalent to four US$[2]). All but one household purchased the stoves at the end of the trial period. Informative social responses to the stoves were collected, but this information was limited, since the social response could only be assessed after a five day trial. My intention from the onset was to return to the research site to further test responses to the stoves, after they had been in circulation for twelve months (June 2010). This additional piece of research would supplement the findings of the thesis at a later stage,

2.4 Methodological tools

Both papers are based on a general literature review. The theoretical findings were assessed against the field observations made on the Nhambita project.

The first paper focuses mostly on energy consumption patterns in Southern Africa and presents an analysis of various stove dissemination rationales, whilst underlining the risks and constraints of carbon offset projects that are based on stove dissemination

[1] For a detailed discussion on the dissemination of stoves as a climate change mitigation measure, see paper 1.

[2] The exchange rate at the time of writing was US$1 = 29 Mts and 1 ZAR = 4 Mts (source: http://coinmill.com/MZN_calculator.html#MZN=30). [Accesed on 15 June 2010].

programmes. These topical areas called for several interviews with industry experts in addition to the literature review and the field research.

Methodological tools used during the secondary field research are as follows (see figure 2):

- In order to get an understanding of the community's surrounding environment and to get an overview of wood consumption patterns and challenges, two participatory rural appraisal sessions (PRA) were held with community members. The PRA tool is a convenient tool which can rapidly provide the researcher with an understanding of the local geography, livelihood means, key challenges and community dynamics (Chambers, 1992; Asia Forest Network, 2002; Chambers, 1994; World Bank, undated). This was therefore deemed a relevant tool to begin the research with. One PRA was held with eight women and gave me the opportunity to appraise their overall livelihood strategies and challenges (DFID, 1998). The other one took place with eight men and focused mainly on the management of communal and individual resources, farming practices, livelihood strategies and perceptions of the carbon offset project;

- Five interviews were held with selected stakeholders involved in project management;

- The core of the secondary research consisted of 40 semi-structured interviews in 40 different households (Barriball and While, 1994; Bryman, 2004). These semi-structured interviews lasted 1h30 on average. This method was favoured because it allows for the collection of systematic information which can be

used to compile quantitative evidence, whilst allowing interviewees to digress and elaborate on relevant topics, thus permitting the gleaning of valuable anecdotic evidence which allowed me to expand the reach of my research (Barribal and While, 1994). These interviews were conducted with community members, both on an individual basis (n=40) and during PRAs, with the assistance of a translator (from Sena into English).

- The energy consumption regime baseline was consolidated by the systematic measurement, with a spring balance, of quantitative wood consumption regimes in all households interviewed (n=40).
- A total of six focus group discussions were then carried out before and after the introduction of stoves. The stoves were distributed to three cluster groups from the three different villages, Nhambita, Boe Maria and Munhanganha. An introduction to the stoves was organized with each cluster, and five days later, a follow up on the social response to the stoves was organized in each cluster.
- This field research is complemented by qualitative observations which attempt to enrich the narration based on quantitative findings.

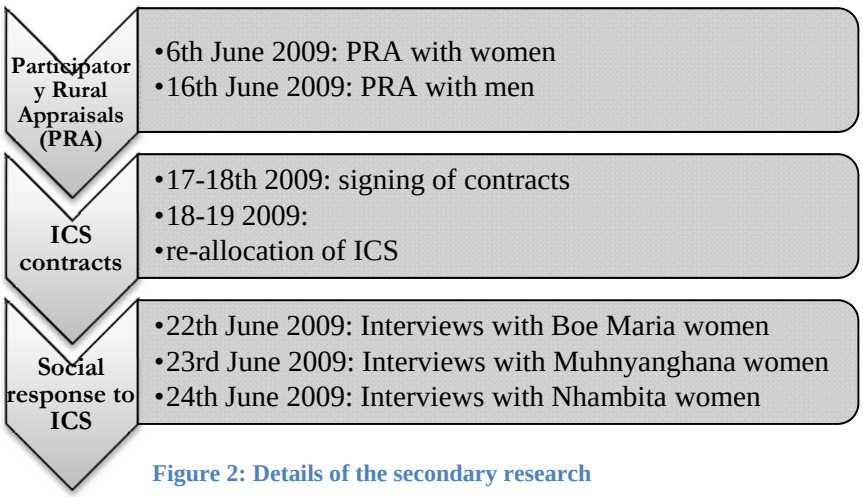


Figure 2: Details of the secondary research

Source: Compiled by the author

It is anticipated that the quantitative information will be relevant to the Envirotrade project team and to any further research conducted on this topic in the project area.

I have used several sources to compile my interview questionnaires. Because the original intent was to use my research as a departing point for a potential carbon offset project, I originally took inspiration from the Gold Standard (Climate Care, undated) methodology to design the interviews. This methodology lists all the information that needs to be included in the Project Design Document (PDD) for submission to the Gold Standard Board. As my research scope evolved into an overall appraisal of community responses to such projects, I adjusted my interview templates with other resources (Probec, undated; Restio, 2009). The socio-economic interview templates also include questions pertaining to perceptions that villagers have of the agro-forestry project. These semi-structured interviews partly inform the second paper. All the interview guides can be found in annex 4.

2.5 Research samples

The households were selected using a simple random sampling method that gave equal chances to households to partake in the research (Jindal, 2004). For this purpose, maps of the three villages illustrating the location of all households were compiled with the assistance of the forest technicians employed by the project (see annex 6). I then visited every third household represented on the map. In the case where there were still no household members present at home after the second visit or if household members were unwilling to partake in the research (which happened on one occasion), I moved on to the neighbouring household.

To define the size of my sample, I had to research the total population in the study area. The number of households and inhabitants in the study area varied according to sources (see table 1). The latest figure of 1,190 people in the study area (Envirotrade, 2008) was adopted for the purpose of the research. My research showed an average of 5.3 people per household, which is slightly below the findings of Envirotrade (2008), with a figure of 5.8 people per household on average.

	Inhabitants (Jindal, 2008)	Inhabitants (Envirotrade 2009)	Households (Envirotrade 2009)	Total number of households interviews	Percentage of households interviewed
Nhambita	355	464	85	15	17.6%
Boe Maria	311	236	39	11	12.9%
Munhanganha	373	490	79	14	16.4%
Total	1039	1190	205	40	100%

Table 1: Sources on the population of the study area and corresponding research samples

Source: Compiled by the author and inspired from Tipper and Grace (2007), 2009 and Jindal (2008).

The size of the samples was deemed representative of the general population. For settlements or groups counting between 300 and 1000 individuals, the Gold Standard Foundation (Climate Care, 2009:7) recommends using a minimum sample size of 10 per cent of the population to undertake kitchen surveys.

2.6 The stoves introduced in the project

The stoves that were introduced in the field are referred to by the manufacturer as 'GreenFire one door[3]' wood cook stoves (StoveTec, undated)[4]. They were designed by the Aprovecho Research Center and manufactured in a Chinese factory. Aprovecho has started mass production and stoves are being shipped to the Americas, Asia and Africa for market testing purposes.

[3] As opposed to the combo stove which can take both wood and charcoal

[4] 'GreenFire One Door' is the name used by the Aprovecho center; it is the same product as the StoveTec, except that the StoveTec was developed under a different brand name.

This specific business model is of relevance to my research, since part of what is discussed in paper 1 pertains to the most efficient way of rolling out ICS in the developing world. The Aprovecho Research Center's approach is based on the external manufacturing of ICS in China to ensure product quality at a minimum cost. It contrasts with other approaches which would for instance focus on building capacity for the local manufacturing of ICS, as in the case of the Jiko stove in Kenya. The challenges I encountered in using these stoves for my research are an illustration of this broader debate and ask important questions with regards to the developmental ambitions of stove projects.

The batch of 20 stoves that are being tested in Nhambita were originally shipped to the ProBec (GTZ) headquarters in Johannesburg, South Africa and Envirotrade then transported them from Johannesburg to Nhambita.

The technical specifications of the StoveTec are as follow:

- The GreenFire One Door is a one-door stove with a ceramic combustion chamber, a painted steel body, a cast iron stove top and a steel stick support.
- Depending on the user, the stoves' useful energy output is 5kW (Malale, 2009).
- The stoves are reported to use 40 to 50 per cent less fuel that conventional stoves or three-stone fires, which means a reduction of emissions between 50 and 75 per cent.

Photo 1: StoveTec introduced in the project area

Source: www.aprovecho.org/

2.7 Methodology challenges and constraints

2.7.1 The reality of the field

To begin with, I may have underestimated the physical challenges associated with field research. I was affected by 'interview fatigue' in the course of my research, which was most certainly compounded by the fact I was taking a strong anti-malaria prophylactic called *Lariam*, known for its negative physical and mental secondary effects and which may have had an impact on my emotional ability to cope with adversity and challenges on the ground.

Logistics were also problematic, since I had no or limited access to transport. Although I did manage to rent bicycles for my translator and myself on a few occasions, these were not always available. I walked or cycled an average of 10 km a day during the course of my research.

2.7.2 Communication issues

2.7.2.1 The language issue

The second most visible challenge encountered during the field research was that of the language. Some of the local villagers spoke Portuguese, which I understood a little, but most spoke exclusively Sena. The Envirotrade camp counted several Shona-speaking Zimbabweans who, because both languages present some similarities, could translate Sena into English. However, Sena remains difficult to understand for a non-native speaker. One of the two translators I employed for the purpose of my research often spent time clarifying the responses of the interviewees because he could not grasp the meaning of some words. As a result, some of the nuances in the thoughts conveyed by respondents might have been lost.

I had a good working relationship with the two translators during the course of the research. However, there is little doubt that the information I collected was filtered by my interpreters' subjectivity, and I frequently reminded them to translate what was being said word to word, thus overcoming their temptation to summarise the responses of the interviewees.

2.7.3 Levels of education and cultural barriers

Communication was also difficult because of the women's overall low level of education. Women were often illiterate and had difficulty measuring time and quantities. If the presence of their husbands during interviews could have, in some instances, affected the objectivity and spontaneity of the women' responses, the input of the men often proved to be valuable and the men overall appeared to be acute observers of the tasks performed by the women, who are exclusively responsible for wood collection and for meal preparation.

One aspect that I underestimated at the onset of focus group discussions was the importance of social status within the community. In the first group discussion with

selected women of the Nhambita village, the President's wife was included. She proved to be very vocal and the other (younger) women were intimidated by her and most did not speak during the group discussion. This was later addressed by organizing group discussions with women of the same socio-economic status.

2.7.4 Difficulty in defining some concepts

Field research should be carried in the most objective and accurate manner. However, when analysing socio-cultural aspects of a community, diverging cultural norms and levels of education make it virtually impossible to adopt one single, straightforward definition. For this reason, I have underlined below the concepts which required some caution when being used in the context of my research. These include the concepts of household, poverty, wealth and time.

2.7.4.1 The concept of household

Adegboyega, Ntozi, and Sekamatte-Ssebliba (1997) define a household as:

> … a unit of people, consisting of one or more persons – related or not related by blood- usually living under one roof and/or making common provisions for food and other living arrangements. Hence a household is basically an economic unit (1997:28).

This notion of 'economic unit' was adopted for the purpose of my research, as opposed to the notion of family, which is "not strictly tied to one location or time, or even… to blood relationship" (Adegboyega *et al*, 1997:28).

Because of the polygamous culture permeating the villages of the study area, the notion of the household as an economic unit makes a lot of sense with regards to consumption patterns of wood. If a man has two wives, he will effectively set up two distinct economic units, each wife having her children stay in her household and having her own fields to sustain her family. As a respondent put it: "(it is important

that) each wife manages her own resources and that she can cook when she wants for her children" (Bernardo, 2009).

Wood is sometimes mutualised if two wives get on well, but it would normally remain the source of a specific household.

2.7.4.2 The concepts of poverty and wealth

Assessing levels of wealth or poverty in the project area proved very difficult at first glance, since almost all villagers appeared to live in similar types of houses made out of rammed earth and wood and to live almost exclusively from the work in their *Machambas*, with little external signs of wealth.

In his socio-economic survey of the project, Jindal (2004) proposed to adopt another indicator, which is that of "ownership of durable items" (Simler *et al*, 2004, as cited in Jindal, 2004). The items identified at the time of his research as good indicators were the ownership of a fishing net or a fishing line, a wristwatch, a bicycle, a radio, a sewing machine or a motorcycle. During my field research, it appeared to me that other indicators could also be used, such as the ownership of solar panels (for the wealthiest), of corrugated iron roofs, of various agricultural tools, and of a traditional cooking stove. Although I have captured the ownership of the above listed items in my research, I have not made explicit use of this information for the purpose of the papers.

2.7.4.3 The concept of time

A significant challenge to my research was the respondents' inability to define time according to western standards. The vast majority of women were unable to give a correct estimate with regards to the duration of certain task. I realized this when I

asked women to indicate how much time they spent in a day boiling water. Three women said, ‘one minute’, which testifies to their lack of knowledge about time calculation.

In order to address this difficulty, questions were reformulated to be asked in relation to the revolution of the sun (Schakleton, 2009). Women were also asked to allocate a number of seeds proportionate to the time spent doing a task, which was depicted on a drawing, to define the notion of time (Photo 2). I conceptualized this research tool, which was inspired by the traditional seasonal calendars often described in research methodologies (CARE, 2009).

Photo 2: During interviews, women were asked to define time allocated to different chores drawn on paper.

Source: author

2.7.5 Challenges in measuring wood consumption

It has been well established that precise direct measurement of fuel wood consumption is exceptionally difficult and rarely reliable, mainly due to its temporal variability (Davis, 1998; Brouwer and Fãlçao, 2004; Shackleton, 2009).

In order to define the wood to be measured for daily estimates, I excluded using head loads as a measuring unit, since the volumes of head loads differ highly between the individuals carrying them (Brouwer and Fãlçao, 2004). Respondents were asked to

indicate the length of time a standard quantity of fuel wood would normally last in their households, an approach advocated by Hiemstra-van der Horst and Hovorka (2008). I went beyond this approach and asked households on which day they collected wood (which was usually twice a week), and indicate to them that I would visit them on that day to measure the amount of wood they planned to use for one day of cooking and heating. I used a spring balance to measure the daily quantities of wood burnt by each household. I would then cross-check this information by returning the next day to check whether all the wood from the pile had been combusted and to ask whether more wood had been added. In the instance where large logs were slowly simmering for cooking, making estimations of daily consumption impossible, I would measure the log put on the fire at a specific time and return the next day at the same time to measure the difference in mass, in order to obtain the wood mass effectively burnt (Shackleton, 2009).

Photo 3: On the left, scale indicating the amount of wood (kg) consumed by this household per day

Source: author

Photo 4: Weighing the wood daily consumed by households with the assistance of my translator Namo.

Source: author

Measuring wood consumption was very challenging and the figures obtained from my research need to be treated cautiously.

Shackleton (2009) points out the importance of making provision for exceptional events such as public holidays[5], funerals and other celebrations, and for seasonal variances in wood consumption regimes. Exceptional wood consumption days were not included in the annual consumption of wood since consumption on those days could not be measured.

[5] The public holidays identified during the field research amounted to a total of five days a year, when respondents are assumed to use more fire wood than usual. These days were the after harvest celebration in June, Children' day on the 1st June, Independence day on the 25th of June, and Christmas.

Photo 5: Woman carrying a head bundle weighing 38kg.

Source: author

For a detailed description on the findings with regards to wood fuel demand in the area, see section 2.7 of the summary on wood consumption in the annexure (annex 3).

2.7.6 Challenges with regards to the introduction of stoves

2.7.6.1 How the stoves were introduced to the community

Stoves were distributed to the selected households over a series of three meetings organized in Nhambita, Munhanganha and Boe Maria. A two hour session was organized with the intent of explaining to the women the reason why the stoves were being offered to them at a discounted price and the positive impact that stoves would have on their health, livelihoods and the environment. This introduction was followed by a demonstration on how to use the stoves (StoveTec, 2009). Recipients were told they would be given five days to decide whether or not they wanted to buy the stove for 200 Mts. If they wanted to buy the stoves, they would need to sign a contract with Envirotrade (annex 7), committing to paying the amount off over two installments. If they did not want the stove, the stove would be presented to another household. This

approach follows the model adopted by the Ugastove Gold Standard Project (Climate Care and CEIHD, 2009).

It appeared that people's responses to the stoves were strongly influenced by the way that the stoves were introduced to them. The group of women from the Nhambita village received their stoves on the premises of the Envirotrade project (Photo 6). Women were too shy to ask questions and the translation of instructions was problematic because I had no 'real' translator on that day. A second informal demonstration was organized within the village, where women visibly looked more comfortable to ask questions and to express their views. Two days after the training sessions, I went to visit the households which had received stoves to observe whether they made use of them. It appeared that most women had not dared to take the stoves out of their packaging for fear of damaging them before becoming the legitimate owners of those stoves. I found that the best way to entice the women to use the stove was to get them to light it and use it in front of us, thus breaking the almost fetishist status that the stoves had gained.

The women in Munhanganha and Boe Maria seemed more pro-active and self confident in using their stoves, although follow-up visits to households revealed that there were still some misunderstandings. One of the women, for instance, was under the impression that the stove could only be used with a metal pot and as she had only clay pots, she bought a metal pot especially to use on the stove, which was not required. The introduction of the stoves in these communities was a far more vibrant process; for me this had a lot to do with the fact that the stoves were introduced in the heart of the Munhanganha village, in a public space gathering villagers both from Munhanganha and Boe Maria (photo 7). This was the opportunity to display the

product not only to the recipients but also to all villagers so that they became familiar with the stoves. I would also argue that the Nhambita village dwellers generally appeared somehow despondent to researchers, which also accounted for the mitigated enthusiasm in receiving the stoves.

Photo 6: Focus group discussion to introduce the stoves in the Envirotrade headquarters

Source: author

Photo 7: Demonstration of the use of the StoveTec in Munhanganha.

Source: author

Lastly, the fact that 20 out of 40 households were selected to be part of the pilot project created a degree of resentment from those who did not receive the stoves. I assume that receiving a stove was perceived as a compensation for the time spent with me, and some households were overtly frustrated for not receiving a 'reward' in the same way others had. Chambers (2006) points out that taking the time of people for research purposes without offering any compensation is a recurrent issue of development practice. Extensive 'after care' discussions were therefore held to rectify people's perceptions of this 'preferential' treatment.

In this respect, I erred by giving in to the request from Envirotrade that the two field technicians working for the project receive stoves as part of the pilot programme. There was merit in this approach, since the field technicians were to act as monitors of the use of stoves in the community and they therefore needed to be familiar with the stoves. However, this compounded the perception that those involved with the project received cumulative benefits that the other villagers did not get.

2.7.6.2 Defining the price of the stoves

I encountered difficulty in defining the right price tag for the stoves. The stoves were donated by Probec; Envirotrade then had to cover the cost of importing the stoves from Johannesburg to Nhambita. They partnered with a local businessman who was transporting goods and made space in his truck for the twenty stoves. Defining the resulting market cost of the stoves was a difficult exercise (see section 5.2 ii of Paper 1).

There were diverging views on how to price the stoves. Some argued that the stoves should be given away for a token fee on the basis that the stoves were donated and to make sure that the stoves would effectively be paid and used. I sustained the view that

in order to truly measure people's Willingness to Pay (WTP), stoves should be sold at a discounted price, but related to its market value. The assumption was that should such stoves be disseminated on a larger scale, some supplementary financial mechanism, carbon finance or other, would not be sufficient to cover the cost of ICS and that beneficiaries needed to carry a portion thereof. Assessing households' WTP would also assist with determining the financial viability of such a programme.

For the above mentioned reason, I thought stoves should not be sold for less than 300 Meticaes (Mts). I managed to convince the team to increase the price of ICS from an original 100 Mts to 200 Mts, on the grounds that it was still a small amount which was easily repayable and that ICS should in no way be cheaper than the simple charcoal burner that could be found on the Gorongoza market for 150 Mts, since the StoveTec is a more valuable and costly item. This amount of 200 Mts proved to be sufficient to cover the importation cost of the stoves to Mozambique. As section 5.2 of Paper 1 shows, the estimated market price of the stove is in fact much higher, with a cost close to 560 Mts (US$19.3) per stove.

In feedback sessions with stove recipients, I tested their appreciation of the 200Mts price and most people voiced that it was very good value for money and that indeed selling it for anything cheaper would be a mistake, as people would resent them for getting something for free. Some respondents also expressed that 200Mts was in fact too little money to ask for the stoves. Tested on a higher price for selling the stove, most people indicated that they would have bought the stove for 300 Mts; past this amount, when asked if they would buy it for 500 Mts, most people responded negatively with some indicating it would still be an acceptable price if it could be settled in several installments.

Envirotrade's field technicians were given the responsibility of handling contracts (annex 7) with the villagers and for transparency purposes; I requested them to give each recipient a receipt acknowledging their payment of the stove. Time did not allow me to ensure this had been done.

2.8 Ethical implications

2.8.1 Social codes

During the whole duration of my field research, I endeavoured to respect and apply the social codes that prevailed in the community. Barribal and While (1994) argue the respect of social ethics assists with the collection of viable information.

To this end, I dressed like the local women did and wore a long skirt ('*kapulana*'). I also sat on straw mats on the ground like the other women. However, the villagers were familiar with the fact that Western women sit on chairs like the men do and at times I accepted an invitation to sit on a chair. Household dwellers were always approached with deference and we did not intrude on their privacy or chores.

2.8.2 Translators: bridges between interviewer and interviewee

As mentioned above, I worked with two translators that I remunerated: Regina, a young Zimbabwean female who was assisting the pastor in his missionary work and Namo, a young Zimbabwean male originally trained as a bird watcher. They both proved to have excellent translating skills from Sena to English, although they are both Shona native speakers.

Working with both proved to be extremely enriching, yet their inherent status and genders were also problematic to my research. Regina was very much appreciated and respected by community members for her work as an assistant to the missionaries. It

appeared that the ‘religious’ aura she had positively impacted on the willingness of women to speak openly in front of her. On the other hand, Namo suited all the requirements of scientific objectivity, but the simple fact that he was a foreign male created weariness among the respondents. Working with Regina was therefore the optimal option for me, but she was not always available.

2.8.3 Interviewees’ responses to the research

Nhambitans see many scientists and researchers coming to do field research in the village. The Nhambita settlement lies on the edge of the Project headquarters premises and is therefore the first point of contact between outsiders and villagers. It was striking to see the difference in the responses to the research I undertook, between the Nhambita settlements on the one hand and the Boe Maria and Munhanganha settlements on the other hand.

The Nhambita women, although they were mostly courteous to my translator and me, at times expressed a degree of lassitude during interviews. This interview fatigue on their behalf was due, according to us, to the too frequent requests for their time that researchers put on them. One woman asked me what she would get in return from giving me her time. There is an inherent risk that research would take up people’s time (Chambers, 2006), and I was cautious not to promise anything in return for their time, apart from a deep appreciation and the offer to give them some of my time in return, whereby they could ask me any questions once the interview was completed. My intention was to put the interviews under the auspices of a cultural exchange and hopefully to put the women more at ease and to make them more willing to share. But most women stuck to their position as ‘objects’ of research and hardly ever took the opportunity to question me in return. Although I wanted to overcome the traditional

mould in terms of my research approach, the outcome was that my research remained fairly conventional. To prove successful, this anthropological approach would require a long immersion in the community. By contrast, the people from Munhanganha and Boe Maria were very enthusiastic at spending time with us and the quality of the interviewees may have benefited from the 'novelty' factor that interviews represented to them.

If most interviewees were very willing to spend just over an hour with me and were amenable in all respects, some women also at time subtly expressed surprise at the nature of my questions. The risk associated with asking questions that are irrelevant or unimportant to the respondent may alter the quality of the information gleaned, since the respondent will have little interest in formulating qualitative responses (Barribal and While, 1994). Reversely, people seemed very willing to exchange their views on the project and how it affected their livelihoods, which proves this aspect had been under-researched..

2.8.3 Reliability of information

The validity and reliability of the information gleaned from semi-structured interviews can prove to be fragile (Barribal and While, 1994) and I addressed these issues by cross checking responses from semi-structured interviews as frequently as possible, through transversal questions and field observations.

Barribal and While (1994) highlight the risks of "non-response" in semi-structured interviews. The meaning of responses heralded in these processes can also be obscured by language, cultural gaps and different levels of education. I encountered this element of "non-response" when focus group discussions were held with women of various social rankings. In these set-ups, young women were ignored.

This “non response” at times also turned into “socially desirable answers” as Barribal and While (1994), citing Patton (1990) underline. This happened as a result of young women generally being shy and impressionable, compounded by the fact that one of my translators was a male from a different culture. I was very aware of this dynamic and recurrently asked him to not hint at responses by sticking to open questions and to reassure them by insisting that there was no ‘right’ answer. The interview process proved far smoother when I worked with my female translator.

Lastly, the validity of the information obtained from semi-structured interviews with the women may have been affected by the presence of their husbands during the meetings. The women are the main people in charge of cooking and fuel wood harvesting, so they would be the best informants on this matter. However, as underlined earlier, high illiteracy rates often made the collecting of quantitative data difficult, which made the contribution of the men valuable. Men generally have higher levels of education and by virtue of their association with the project (as carpenters, foresters, technicians, etc.) are more accustomed to interacting with Westerners. Their self confidence, however, may have allowed them to speak about issues about which they knew less than their wives did.

2.8.4 Ethics between researcher and subject of research

The suspicion I raised as a researcher was unequivocal. I endeavoured to clearly express that I was not part of the project; however, it retrospectively appeared that a few people had thought I was actually working for the project. But the quality of the quantitative information collected on wood consumption was not influenced by this original misperception, since all statements were validated against information on the ground.

My status as a researcher was also a little ambiguous, since on the one hand I was acting as an objective observer of wood consumption patterns and kitchen regimes, whilst on the other hand I ended up rolling out a pilot stove programme which implicitly made me the advocate of stoves. The fact that I rolled out this programme earmarked a switch from anthropological observer to project developer and created a difficult interstice to act in. The first space calls for neutrality, whereas the second dimension involves emotions and a willingness to influence people's behaviours. This dual dimension created a grey area in which it was challenging to maneuver, given how important it was to keep those two roles apart.

Conclusion

My research was mostly based on a literature review, which was complemented by a month long field research, from which I extracted empirical evidence to ground my findings.

In this methodological section, I have introduced the field research site and then presented the rationale for the two papers written for the purpose of the Master in Sustainable Development Management and Planning. I then discussed my methodological approach and the tools used to glean the required information. In the course of my field research, I have encountered several methodological challenges and constraints, ranging from communication barriers; difficulty in defining socio-cultural and spacio-temporal codes which differ according to cultures; diverging views from the Envirotrade management team with regards to the methodology to be adopted to introduce the stoves; and time constraints to thoroughly test the social response to ICS. These issues, together with the ethical implications of my research, were acknowledged and discussed extensively.

These methodological constraints, however, do not invalidate the quantitative or qualitative findings of my research, as I have been able to demonstrate how these issues were overcome, whilst calling for caution in some aspects of the research. The qualitative findings pertaining to the daily consumption of fire wood by households was undertaken with the highest degree of rigour, given my limited resources and the limited time available for the research. My approach was informed by experts' interviews, a literature review and trials on the ground and it could withstand the scrutiny of practitioners.

The most obvious limitation of my findings pertains to the limited time granted to research subjects to experience with the ICS. This research therefore calls for a follow-up, which should be undertaken when I have the necessary resources to follow up or which could be undertaken by a fellow Mphil student. The methodological approach I have adopted made provision for follow up research, since I have kept the record of all the households interviewed, together with their location with GPS coordinates and hand drawn maps (annex 6). The impact of the introduction of ICS in 20 households could be monitored by comparing wood consumption patterns in the target group, against wood consumption patterns in the control group.

Paper 1 and paper 2, which constitute the core of my thesis, follow in the next sections.

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5. PAPER 1

Improved wood cooking stoves: a way of modernising the use of biomass in Southern Africa and reducing CO_2 emissions?

Opportunities and risks of carbon offset stove programmes with reference to the Nhambita test case in Mozambique.

Synthesis article to be submitted to the *Climate Policy Journal.*

Keywords: Improved cooking stoves (ICS), modern uses of biomass, carbon offset, deforestation, Bottom of the Pyramid.

Abstract

Africa is the most poverty stricken of all the continents in terms of energy. Projects to provide the Poor with energy generally involve the provision of electricity or petroleum-based products. Such schemes are rarely affordable and are premised on misinformed assumptions about the uses of and customs surrounding biomass in Southern Africa. Improved Cooking Stoves (ICS) have been heralded as a panacea to address energy needs, whilst contributing to alleviating pressure on biomass, which will remain the main source of energy on the sub-continent in the decades to come. However, the paradigms underpinning previous stove programmes in the past decades have only resulted in an estimated penetration rate of ICS inferior to 0.1 per cent in the sub-region. This requires an appraisal of the rationales and approaches to be adopted to promote their use on a large scale. Based on a review of the pertinent literature and on field work conducted in Mozambique, the paper explores how a new understanding of the market of the 'Poor', which places the targeted end-user at the centre of developmental praxis, should shape the technological and marketing approaches to be adopted for a large scale dissemination of ICS.

1. Introduction: the energy market in Southern Africa

Africa is severely affected by energy poverty: with energy prices double that of world standards, very unreliable supply chains and a declining electrification rate (Eberhard *et al*, 2008). Access to energy is inequitable, with the average grid connection rate estimated at ten per cent of households (Eberhard *et al*, 2008). In developing nations, the urban poor generally pay more per unit of energy than the wealthiest quintile of the country's population (Karekezi, 2002). The development of an energy market for the poor therefore implies an alleviation of this "poverty penalty" (Prahalad, 2004:36).

Biomass in the form of wood and charcoal is the most preponderant energy source in Africa (Leach and Means 1988:1; Gieling, 1991 as cited in Shackleton, 1997; Shackleton, 1997; Mangue, 2000). Research has shown that up to 90 per cent of African households use open fires (Kgathi and Zhou, 1995 as cited in Bass *et al*, 2000). The need for cooking energy is paramount in poor households in developing countries; this currently accounts for approximately 90 per cent of their energy demand (Bhattacharyya, 2006). According to Amous (2000), the global annual growth in wood fuel demand in Africa and Latin America has been on par with population growth, ranging in the past decades between three and four per cent.

In recent years, the questioning of the 'energy ladder' paradigm (Kebede *et al*, 2002; Brouwer and Fãlçao, 2004) has been concomitant with the increasing awareness of the sizeable role that biomass will play in addressing future energy needs in Africa (Geist and Lambin, 2002; Arnold, 2006, citing Broadhead *et al*, 2001). The energy ladder tenets assumed that with increased levels of wealth, households, especially in urban areas, would systematically allocate a higher proportion of their income to more expensive and more practical energy resources than wood.

Numerous contemporary cases illustrate the oversimplification of such assumptions, since many households across the income spectrum still use biomass energy, simultaneously with modern sources of energy (Brouwer and Fãlçao, 2004). Hiemstra-van der Horst and Hovorka (2008) demonstrate that wood fuel is in essence the energy source of the Poor and that the switch to more 'modern' energy sources mostly depends on income levels. Their 2008 research on fuel mixes in the city of Maugang, Botswana found that:

> … wood reliance was due to inability to access alternatives (3%), its superiority to all alternatives (5%), its effects on food taste (9%), tradition or familiarity (11%) or ready availability (15%). Just over 83%, however, stated that its use was due to its low cost (2008:9).

An extensive literature underlines this strong correlation between income levels and the type of energy sources consumed. Wood is regarded as the predilected energy source of the Poor, mainly because it is freely available (Karekezi and Majoro 2002; Bhattacharyya, 2006; Atken, 2009; Hancock and Balmer 2009b:14).

Furthermore, when electricity is available, it is not used exclusively but in combination with a plurality of fuel sources (Restio Energy, 2009). In Maputo for instance, the rising incomes of urban households led to an increased consumption of charcoal, in correlation with alternative non-biomass energy sources (Brouwer and Fãlçao, 2004), rather than an increase in electricity consumption, as would have been assumed by the 'energy ladder' theory.

On the one hand, recent literature has underlined the limited recognition that biomass has received in terms of the economic and livelihood capital it represents (Shackleton *et al*, 2001; Blignaut *et al*, undated). Shackleton and Shackleton (2004) emphasise that although forest ecosystems do not constitute a source of poverty alleviation *per se*, they nonetheless prevent rural households from falling deeper into poverty, a notion

corroborated by the role of forests as livelihood "shock absorbers" (Shively, 2005, as cited in Shackleton and Shackleton, 2004). Shackleton *et al* (2004) found that, translated into monetary terms, the gross direct-use value of fuel wood in South Africa amounted to close to three billion Rands per year to the national economy.

On the other hand, this literature omits inquiring into the health, socio-economic and environmental hazardous impacts associated with the combustion of biomass. This evidence calls for a reconsideration of common perceptions of biomass use in Southern Africa.

2. Critical analysis and conceptual framework: modernising the thinking and the usage of biomass

For the purpose of this paper, the notion of energy biomass in its "harmless form" (Karekezi and Ranja 1997) has been adopted as the most suitable definition to refer to a 'modern' energy source. The use of ICS fits under this definition, in that ICS can render the use of biomass risk free (no risk of fire spreading, no risk of personal injury), safe (as in non-toxic, safe to handle) and non-detrimental to the environment, through a reduced use of biomass, which is estimated at 40 per cent in the case of the StoveTec stoves tested in the field research (StoveTec, undated).

There is today overwhelming evidence that anthropogenic activities resulting in the release of carbon dioxide (CO_2) in the atmosphere are the leading cause of global warming (Stern, 2006; IPCC, 2007). In Africa, electricity is mostly generated from fossil fuel-fired (mostly coal) generation, with hydropower playing a marginal role overall (EIA, 2009). The electricity generated in Africa is carbon intensive and therefore cannot be regarded as a 'modern' energy source, since externalities associated with its production are not taken into account (Wackernagel and Rees,

1996). One could argue that energy emanating from “ancient sunlight” (Hartmann, 2004:10), which forms the petroleum based energy sources of today is, *de facto*, the ‘dirtiest’ and therefore the least ‘modern’ source of energy. The use of biomass, if fully combusted and renewable, can therefore be construed as a modern energy source.

In view of the above, ICS constitute a modern energy carrier, since their use allows for improved combustion and efficiency – thus offering socio-economic and health benefits - and for reduced amounts of fuel wood – thus contributing to the preservation of forest ecosystems. The critical assessment of these benefits advanced by ICS project practioners forms the departing point of conceptual framework to this paper.

An additional preliminary question to ask is whether a large scale dissemination of stoves would herald benefits for Southern African economies. The debate on the dissemination of low technology devices in developing economies is interwoven with the question to know whether stoves should be manufactured locally - thus incorporating the poor in the production value chain - or imported, which can result in positive scalability but also create a negative dependency of local economies on importations and money inflows, whilst enriching the manufacturing sector of external countries (Stamm, 2010). The later approach is justified by the imperative to ensure the availability of a product meeting quality standards and to avoid design drift risks (Aitken, 2009).

Furthermore, one of the most important biomass institutional players in the Southern African Development Community (SADC) region, the Programme for Basic Energy and Conservation (ProBec), has overtly opted for the importation of stoves, thus

expressly dissociating the penetration of ICS in the region from local manufacturing development. Probec underlines that the first steps in mass dissemination of ICS in Southern African could only be taken once a product could be made available in large and scalable quantities (Balmer, 2010).

Whilst acknowledging the potential pitfalls associated with ICS dissemination as a remedy to energy poverty, the paper is premised on the assumption that ICS projects can be beneficial if the business models adopted for their dissemination are well suited to local circumstances. Beyond and prior to the need to identify adequate distribution mechanisms, practitioners need to ask themselves the relevant questions in terms of the conceptual approaches driving ICS dissemination. Why would local communities in Southern Africa make use of ICS? Is this technology relevant to local livelihoods?

The history of stove dissemination is riddled with failures and few success stories (Balmer, 2010). Factors pertaining to financial, design, cultural and marketing issues account for this mitigated achievement (Karekezi and Ranja, 1997). The rationales and project designs promoted to date to encourage a wide dissemination of ICS designed and manufactured by local artisans in Southern Africa have resulted in an overall penetration rate of ICS estimated to not exceed 0.1 per cent in the sub-region (Balmer, 2010). If biomass is to remain the main energy source in Southern Africa, a new way of appraising this resource is needed. This begs the question of which factor, or rather, which argument, could drive a mass commercialization of ICS. In other words, what are the 'pull' factors which would lead to an increase of the demand? And what are the 'push' factors leading to a more appropriate, accessible, affordable and available (Anderson and Markides, 2007) supply of stoves?

It appears from past practice that a discrepancy is emerging between the compiling of arguments in favour of ICS dissemination from the 'developers" perspective and from that of the targeted communities' perspective. Are the environmental, economic and social arguments (Gupta and Ravindranath, 1997) advanced by those developing ICS carbon offset projects enriching the livelihood strategies of those for whom they are intended? What assumptions, potentially overlooking traditional uses and customs of biomass and responses to the introduction of technological innovations, are made? How do these assumptions possibly endanger the success of such interventions?

In order to appraise the viability of stove dissemination in Southern Africa, different aspects of the stove value chain need to be analyzed. Firstly, pre-conceived ideas about how biomass resources are exploited and their resilience to human activities need to be revisited (Shackleton *et al*, 2001; Shackleton and Shackleton, 2004; Blignaut *et al*, undated). Recognizing that past rationales underpinning ICS dissemination programmes have had limited impacts, and taking stock of the 'real arguments' that from a praxis point of view could appeal to the end user, will constitute important future steps.

Engaging with the targeted households further calls for innovations in the development of business models underpinning stove dissemination programmes (Hancock and Balmer, 2009).

The 'Bottom of the Pyramid' (BOP) concept coined by Prahalad (2004) in his pioneering work about the significant market constituted by the two thirds of humanity living on less than US$2 a day, overhauls pre-conceived ideas about the buying power of the Poor and implies that a shift is needed in the way that this market segment is engaged with.

In view of the above guiding principles, the paper is structured as follows. First, the methodology used is described. The paper then examines past and current arguments underpinning stove dissemination programmes, in an attempt to understand past failures and to assist with identifying the successful keys for a paradigm shift. The results of a pre-feasibility study on the introduction of efficient wood stoves in the Nhambita community (Mozambique) are used as a test case to question commonly held assumptions on ICS, which might have hampered the success of ICS programmes.

3. Methodology

The findings of this paper are based on a literature review, experts' interview and field research. The field research was undertaken within the Chicale *Regulado* (Northern Mozambique), in which a consortium of organisations managed by Envirotrade (Pty) Ltd, spearheaded reforestation activities, together with 'Reforestation and Avoided Deforestation and Degradation' (REDD) activities in the buffer zone of the Gorongoza National Park. Local villagers in the *Regulado* enter into contracts under the *Plan Vivo* voluntary standard, under which they commit to planting and protecting trees over a period of time. Energy consumption patterns and cooking regimes of the people living in three rural villages, namely Nhambita, Boe Maria and Munhanganha (the study area), were studied (n=40) prior to the introduction of a pilot project to test the response to 'StoveTec' wood burning stoves (n=20).

The field research comprised of semi-structured interviews (While, 1994; Bryman, 2004) with the target group (n=20) and with the control group (n=20). In addition to the interviews, two Participatory Rural Appraisal (PRA) sessions were held with community members (Chambers, 1992; Asia Forest Network, 2002; Chambers, 1994)

to appraise the community's livelihood strategies and to get an overview of wood consumption patterns and challenges. The amount of wood consumed in those 40 households was weighted.

Due to time constraints and logistical difficulties, extensive field research to assess the response to the ICS could not be conducted. The field work is referred to in this paper merely as anecdotal evidence, in order to illustrate the literature on the topic and ground the discussion in an empirical case study.

4. Traditional arguments underpinning wood stoves programmes

The problem areas that stove programmes have needed to address are multifaceted and range from overall improvements in livelihoods and health, to environmental concerns. These areas of concern, which can be construed as arguments advanced to construct dissemination rationales, are reviewed in an attempt to shed new light on this debate.

4.1 The Fuel wood crisis argument

The introduction of 'modern' biomass technologies, in the form of efficient wood stoves and supplemented by the planting of buffer woodlots, has known a precedent during what was first coined the 'wood fuel crisis', when governments in the 1970s encouraged the protection of wood resources from the 'encroachment' of wood cutters. This 'fuel crisis' argument was sparked by a fear, at the time, that given current trends of wood consumption in the developing world, forest cover was on the verge of an imminent disappearance (Leach and Means, 1988).

The reductive theory that fuelled this knee-jerk response in the wake of the 1973 oil shock was criticised by several authors (Leach and Means, 1988; Shackleton, 1997; Contrearas-Hermosilla, 2000; Geist and Lambin, 2002; Sengupta and Maginnis,

2006). In part this 'gap theory' was criticised for assuming that wood resources would dwindle in correlation with population increments, without taking into account the diversity of coping or life strategies of African households in the context of scarcer resources, and overlooking the ability of biomass resources to regenerate through coppicing (Shackleton and Shackleton, 2004; Bensel, 2008). Borsboom *et al* (2002) debunk the fuel crisis myth in the following terms:

> There is no general link between fuel wood use and deforestation; fuel wood use does not trap people in poverty; fuel wood is not being phased out; it is not a marginal product; and it is not just a traditional commodity serving poor people (2002:267).

Crewe (1998) depicts how stove programmes launched in the 1980s were dismissed as failures, because 'they were apparently rejected by many users, and they were not reducing the rate of deforestation' (1998:99). She explains how this first wave of abandonment resulted in a drastic change in donor policy, with stove programmes being largely deleted from aid programmes by major United Nations agencies, the World Bank and multilateral donors.

It is now widely acknowledged that land use change in various forms, ranging from infrastructure development to agricultural encroachment, rather than fire wood harvesting *per se*, is the main driver of deforestation (Contrearas-Hermosilla, 2000; Borsboom et al, 2002; Geist and Lambin, 2002; Sengupta and Maginnis, 2006).

A new body of literature referred to as 'forests in transitions' points to a new paradigm, which through empirical evidence contradicts and further invalidates the assumptions in which the 'fuel wood crisis' argument is rooted. The idea at the core of this emerging concept is that local communities interact with forest resources in a dynamic way. These communities would respond to scarcity by growing trees, which would translate into the emergence of wood markets (Rudel *et al*, 2005; Bensel, 2008). This is the case in the research area, where villagers are encouraged to plant

green manuring pigeon pea trees on *Machambas* (the Portuguese term used to designate agricultural fields), so that they can use the coppiced branches as fire wood (Grace, 2007). In this same project, a communal decision was made to no longer cut live trees for fire wood but too exclusively rely on the use of dead wood (Sera, 2009). The paper will further make the case that the observed abundance of biomass in the research area invalidates the 'fuel energy crisis' argument.

If biomass harvesting cannot be posited as a main cause of deforestation, it is acknowledged to be a cause of forest degradation[1]. Degradation depends on the intensity of harvest[2] and on the nature of the biomass harvested. The harvest of dead wood for instance, is far less detrimental than the production of charcoal. Shackleton *et al* (2004:351) contend that since only one to two per cent of total woody biomass is on average available for harvesting and because very few nutrient cycling and carbon are stored in dead biomass, dead wood harvesting can generally be construed as sustainable harvesting.

In the Chicale *Regulado*, the two main drivers of deforestation are agricultural encroachment and charcoal production (Tipper and Grace, 2008). However, charcoal production is banned in the buffer area of the Gorongoza National Park and mainly takes place to the west of the N1.

It appears obvious from this analysis that biomass scarcity cannot be construed as a uniform problem in Southern Africa and that differentiated solutions need to emerge for different contexts and geographical areas. The key issue is that of localized, unsustainable harvesting practices (Arnold *et al*, 2006) within a biome which appears to be overly resilient to high harvesting rates. This means that "the wood resource is sufficient; it just calls for management practices that can hallow sustainable cropping

rates" (Shackleton *et al*, 1994: 166). From a resource protection perspective, wood stove programmes are therefore only relevant in specific areas of scarcity.

4.2 The health argument

The health argument has permeated all phases of stove dissemination programmes, but has been prominent since the late 1990s, with cumulative research completed on the topic, especially from the World Health Organization (WHO). The negative health impacts associated with the use of biomass have been well documented: "Levels of particulates, sulphur dioxide and carbon monoxide in wood smoke generally exceed World Health Organisation standards by more than 100%" (Van Horan and Eberhard, 1995, as cited by Shackleton *et al*, 2004). WHO estimates the number of fatalities related to indoor air pollution (IAP) to 1.6 million people (WHO, 2002). Women bear the brunt of respiratory related illnesses, since being responsible for most the cooking, they are exposed to twice as much particulate emissions as their male counterparts (Karekezi and Majoro, 2002).

However, if these remain paramount problems to be addressed, praxis reveals that health is not a major preoccupation from the perspective of the end user. Atken (2009) contends that in order to promote the uptake of ICS by rural communities in South Africa, the cost savings aspect remains the most compelling 'marketing' argument to engage with the targeted user. Extensive training will be required to create awareness on the noxious health impacts of IAP. The field research in Nhambita found that villagers were mostly unaware of respiratory diseases related to smoke inhalation. Interviewed households members did not find smoke from cooking fires inconvenient, with some underlining the important function that smoke played in repelling insects that attacked their crops stored in the attics of their kitchens, under which cooking

fires are lit. Participatory sessions revealed that women are interested in stoves for both increased societal status and the convenience of cooking.

Introducing stoves on the assumption that women would want them for health reasons, a notion mostly promoted by external agents, only makes sense in a context where ICS are donated. ICS projects with a commercial rationale aiming at mass distribution can therefore not base their marketing on health issues.

4.3 The socio-economic argument

The socio-economic implications of heavy reliance on biomass have traditionally been put forward as an argument to promote wood stoves. The literature underlines the frequency of physical injuries, as distances to resources increase, leading to heavier loads being carried (Van Horan and Eberhard 1995 as cited by Shackleton *et al*, 2004) and to women being more vulnerable to attacks (Hassen, 2006). The argument is also made that wood collection is a time consuming chore for women and that it implies time away from agricultural activities and from the education and care of the children (Hassen, 2006).

The socio-economic impacts of increasing wood scarcity, if they are real, have however been over-inflated. The perception that wood fuel should be measured according to the availability of the resource is misleading. In their research on poor rural households in Malawi, Bandyopadhyay *et al* (2006) found that decreases in biomass only had a marginal effect on time allocated to fuel wood harvesting, one cubic metre less of biomass equating to one additional minute spent walking.

Leach and Mearns (1988) argue that a more suitable parameter to measure the socio-economic impacts of resource scarcity is that of labour availability, measured against

resource availability. The allocation of the women's time to wood collection versus other domestic tasks constitutes the main discriminating factor; fetching wood even in a context of abundance can be perceived as a serious burden, depending on how much time other chores take up.

A common perception which transpired from the literature written on the Nhambita project (Jindal, 2004) is that women spent a large portion of their time collecting wood. However, participatory rural appraisals revealed that this task was the least time consuming of all domestic chores carried out by women. Wood collection was ranked after farming, preparing meals (crushing, sorting, drying, cooking), and fetching water in terms of time consumption. Following women collecting wood revealed that return trips took on average one hour. This chore was often linked with another activity; they would typically collect wood on the way back from going to work, from the *Machamba* or from visiting someone.

4.4 The carbon offset argument in the context of Climate Change

The 4th Intergovernmental Panel on Climate Change (IPCC) report (2007c) offers the most compelling evidence that human activity is the main cause of climate change. The scientific terminology used to refer to the influence of a given factor on climate change is 'radiative forcing', meaning that unnatural factors are "(pushing) the Earth's radiative balance… away from its normal state" (IPCC 2007a:101)", which results in global climate changes.

The Green House Gases (GHGs) that receive the most attention in terms of radiative forcing are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the halocarbons (IPCC 2007:101). The combustion of biomass (Andreae and Merlet, 2001; van der Werf, 2004, cited in IPCC 2007b:138) and deforestation are significant

contributors to GHGs (Houghton, 2003, as cited in IPCC, 2007b:138) with land use changes contributing up to 18 per cent of global GHG emissions (IPCC, 2007).

However, in climate change circles, the combustion of biomass is regarded intrinsically as a carbon neutral activity, the assumption being that carbon released from biomass combustion is reabsorbed or stored through the photosynthesis process into new growth (Bhattacharya and Salam, 2002:307). Carbon neutrality depends on whether i) the resource base is renewable and ii) whether the biomass is fully combusted.

Biomass renewability (UNFCCC, 2009a) relates to the concept of sustainable harvesting, which implies that extraction must not exceed the natural "…regeneration rate of the resource (and) impair the potential for similar harvests in the future" (Goodland *et al*, 1990, as cited in Seydack 1995: 140). Therefore, harvesting intensity and frequency constitute key parameters in determining the renewable status of the energy base.

The second concept pertains to the fact that biomass used for domestic purposes on open fires or on traditional biomass cooking stoves, is not fully combusted (Bhattacharya and Salam, 2002). The products of incomplete combustion (PICs) include soot, also commonly referred to as 'black carbon' (BC). BC is emitted through the combustion of fossil fuels and biomass, which constitute a GHG with a strong warming potential because its radiative forcing is higher than that of CO_2 (Baron *et al*, 2009).

There are currently two CDM methodologies which could subsidize the costs associated with ICS dissemination, if it can be established that their use offsets CO_2, namely: "Energy Efficiency Measures in Thermal Applications of Non-Renewable

Biomass" (AIMS II.G) (UNFCCC, 2009a) and "Switch from non-renewable biomass for thermal applications for the user" (AIMS I.E) (UNFCCC, 2009c).

A methodology has also been developed in the Voluntary Market under the Gold Standard (Climate Care, undated). All methodologies would validate a project as "additional"[3], provided that the biophysical resource is proven to be non-renewable. Whether the consumption of fire wood contributes to this non-renewable status is of paramount importance, since it ultimately conditions the legitimacy of introducing ICS to alleviate deforestation.

For the carbon offset argument to be validated, a project needs the following assumptions need to be validated:

- the ICS used reduces GHG emissions (additionality);

- the biomass 'saved' through the use of these stoves would have otherwise disappeared and further endangered a local ecosystem. Sources on this topic of 'non- renewable biomass' are limited and these methodologies are still being refined (Stiles, 2009). However, the discussion on this issue is essential to identify the challenges and weaknesses of this concept.

- the stoves will be effectively used by the intended beneficiaries.

Each of these assumptions is discussed hereunder, in light of the field research which was undertaken.

i) Reduction of GHG emissions

Avis (2004) reviewed work done on assessing whether wood stoves contributed to reducing GHG emissions. The important finding from our perspective is that GHG emissions reductions fluctuate significantly according to: the type of stoves originally used versus the new stove technology adopted; whether the use of the stoves is considered under a renewable or non-renewable harvest scenario; and the type of fuel used. Her research revealed that the use of some stoves may in fact increase GHG emissions. For instance, the use of the 'rice-fuelled improved mud stove' is shown to increase GHG emissions. This proves that a specific design is required to make stove usage 'additional'.

In the research area, all respondents but one (who had a traditional charcoal stove) used exclusively three stone fires. Given this baseline, a 40 per cent emission reduction with the use of StoveTec stoves could reasonably be assumed (StoveTec, undated).

ii) Non-renewable status of biomass

On the second issue of proving that the biomass base in the project boundary is not renewable, important points can be advanced in the context of the Nhambita test case.

In the research area, 95 per cent of respondents collected exclusively dead fire wood for their cooking needs[4]. Shackleton (1998) argues that the ecological impact of dead wood extraction is minimal. If its harvesting may affect micro-biodiversity, overall ecosystems remain unscathed.

It can therefore be argued that current levels of wood extraction in the research area do not constitute a threat to the overall levels of biomass. But in order to assess the

validity of this finding in a spatial and temporal context, the important question to ask is whether the fire wood "frontier" (Leach and Mearns, 1988) has been reached. Dead wood in the project area is extracted from both adjacent forests and from *Machambas.* 46 per cent of respondents collected dead wood from *Machambas* and the remainder collected wood mainly from the forests. Wood collection from *Machambas* is cyclical and depends on when a fire last occurred on the field, thus 'freeing up' fire wood. This implies that the fuel wood frontier is very dynamic and continually pushed back and therefore that wood freed from *Machambas* will constitute an ongoing source of fire wood. Once this reserve runs out, household members would normally resort to collecting dead wood in the secondary forest. Households which have a *Plan Vivo* contract have committed not to extend their fields[5]. These households most probably have no fire wood left on their fields and can only collect s from the forest. Since the opening of new M*achambas* is considered a major source of deforestation, it can be argued that this trend was overcastting fire wood extraction patterns. The moratorium on the opening of new *Machambas* will thus lead to more wood being collected in the forest[6].

It can thus be concluded that wood extraction at this stage does not constitute a threat and that the biomass in the project area can be considered as renewable. But as fire wood in the *Machambas* runs out, more pressure will be put on forests and perhaps compromise this renewability of the biomass.

In questioning the correlation between deforestation and fuel wood usage, it is clear that the challenge is to define the proportion of fuel wood that contributes to effective deforestation, as required by carbon methodologies.

In the Nhambita project boundary, charcoal is extensively produced (Herd, 2007) but the product of this activity is not consumed locally; charcoal is mostly transported to Beira or purchased by individuals on the side of the road (Brouwer and Fãlçao, 2004). The carbon footprint (Wackernagel and Rees, 1996) of large African cities and the pressure they put on their hinterland is effectively the exogenous driver of deforestation activity. Carbon offset projects based on ICS should therefore incorporate this rationale within the methodologies.

In this context, one could argue that the use of ICS in rural areas which are close to an abundant resource base and especially a resource base that is protected in the context of a REDD project is not qualified as additional in terms of emissions reduction. In Nhambita, although most interviewees indicated that in their perception there were less trees than ten years ago (66 per cent of respondents) and that they had to walk longer distances to collect wood (75 per cent of respondents), observations on the ground revealed that there was in fact a great availability of fire wood. 58 per cent of households indicated leaving their fire burning throughout the day, which was confirmed by field observations. Especially affluent households would leave heavy logs smoldering throughout the day, even when they are not cooking[7]. In households where labour is less readily available (in the case of newly established couples with no or just one child, monogamous couples, frail elderly households) because time is mostly allocated to cultivating the fields, people would systematically put their fire out after cooking the meal and then go to their neighbour to get coals to reignite the fire.

Since fire wood is strongly correlated to the opening of *Machambas*, it can be argued that the development of a stove carbon offset project in Nhambita would complement

the REDD project, as it would contribute to the alleviation of pressure on the forests. But because the resources are not considered as threatened, the project has no additionality, which doesn't mean that the resource base will not be threatened in the future. We are thus confronted with an overlap of emission baselines – that of the REDD/*Plan Vivo* on the one hand, and the stove project on the other hand (Goodman, 2009).

To add to the confusion, Avis (2004) stresses that in fact, the renewable or non-renewable status of the biomass harvested for combustion may be irrelevant if put in correlation with other factors such as the type of fuel used or the stove technology used:

> ... Emissions savings from some improved stoves under renewable harvesting are comparable with savings under non-renewable harvesting, suggesting it is worthwhile to include renewable harvesting ICS projects in carbon trading in certain circumstances (2004:36).

It is admitted by developmental practitioners that the weak methodologies pertaining to stove projects constitute an implicit way of allowing stove dissemination on the basis of an environmental argument (lower emissions), whereas the developmental intent could be perceived as being of a social nature (Stiles, 2009).

iii) Effective use of stoves

A third assumption is that the stoves will be used and that their use will contribute to decreasing the amount of fuel used for cooking. In the field research completed in the Nhambita pilot project, the women commended the high efficiency of the stoves and indicated that they had significantly reduced the amount of wood required for cooking. However, whether the stoves will be used as intended is questionable, given the social norms surrounding fire usage in the community.

Field research revealed that 20 per cent of households had two fires burning at the same time at any given time of the day. This was the case where several households shared a communal area, particularly in polygamous set-ups. Each wife has her own house, but she shares the courtyard where all the crushing, meal preparation, cooking and socialising takes place. Once they have children, the sons who come of age at times build a house close to the parental house where his wife will join him to start a family. The extended family therefore lives in the same perimeter, but with clearly defined gender barriers. Culturally, men cannot be associated with the cooking duties; they are, as a woman put it, "not authorised to go near the fire where the pots are cooking" (Interviewee, 2009). The men therefore make their own fire to sit around, mostly in the evening. The women do not sit around that fire, although not all households respected this convention strictly. 'Dual fire' situations could frequently be found in the village. It can therefore be assumed that the use of ICS will only partly diminish emissions, since open fires will always be used for social gatherings.

It appears from this discussion that carbon offset markets offer a mitigated potential to raise the required finance to disseminate ICS on a large scale. Demonstrating the non-renewability of biomass proves challenging, especially in contexts where biomass appears to be abundant and where customary use of fires might constitute cultural barriers to such projects. To a certain extent, the GHG emission reduction argument is reminiscent of the 'fuel wood crisis' (section 3.1) and encounters similar limitations in its foundations.

4.5 Paradigm shift: the Bottom of the Pyramid

As demonstrated above, the donor sector intermittently seems to gain or lose interest in ICS programmes, depending on technological breakthroughs and on the appraisal

of the socio-economic and environmental context at a given time. The negative trend which prevailed in the 1980s and early 1990s was according to Crewe (1998) reversed in the late 1990s, when DFID started appraising the performance of ICS under a new light. Increased efficiencies in wood consumption then started bolstering ICS projects.

This interest in ICS was further bolstered with the new thinking brought to the forth by Prahalad and the BOP concept (Prahalad, 2004). Through this concept, the private sector is awakened to untapped opportunities in the market segment of the Poor. But making goods accessible to this market challenges the business models of multinationals which have in the past shunned the Poor. The market of the Poor is characterized by very low and sporadic revenues; it is therefore very challenging for the Poor to make capital investments. According to Prahalad (2004), corporations therefore need to explore all avenues to address the primal imperative of lowering the cost of goods or to otherwise subsidise the dissemination of products. Innovative stove products, if they cannot meet the Poor's Willingness to Pay (WTP) should thus be accompanied by innovative finance mechanisms.

Foley's (1995) 'bottom of the ladder' theory stipulates that energy needs should be construed through the lens of poor people's primarily subsistence needs, which are mostly addressed by wood based fuels. Besides wood, additional non-biomass fuels are juxtaposed to answer the emergence of new and fluctuating needs. In view of the above discussion, a new paradigm could be proposed as a means to overhaul previous rationales for ICS dissemination projects. For any ICS project to be viable, it should be based both on the 'Bottom of the Pyramid' concept and on the 'Bottom of the (energy) Ladder' concept (BOPBOL).

5. *Summary and conclusion on ICS programmes arguments*

Table 1 summarises the arguments used for various stages of ICS dissemination programmes, the actors driving these projects and their outcome.

Time period	Argument used for ICS dissemination	Rationale/ marketing argument	Actors	Out-come	Comments
1970s	Wood fuel crisis (Environment)	Depletion of forests in developing countries	National govern-ments, NGOs	Failure	The reductive 'gap theory' macroeconomic approach was criticized by several authors (Leach & Means, 1988; Shackleton, 1997; Contrearas-Hermosilla, 2000; Geist and Lambin, 2002; Sengupta and Maginnis, 2006) (see section 3.1)
1970s to date	Health	Livelihood benefits through the reduction of PIC, the main cause of Indoor Air Pollution (IAP) a large cause of mortality	WHO NGOs	Failure	The approach is donor driven and the health argument does not constitute an inciting factor for the end user. Generally speaking, the 1980s and early 1990s were characterised by a disinterest of the donor sector in ICS programmes (Crewe, 1998).
1997	Overall livelihood improvements Environment	Significant progress has been made in stove technology	DFID	Too early to assess	The interest in stoves was revived in the donor arena with the 1997 DFID *White Paper* on stoves, underlining new efficiency gains (as cited in Crewe, 1998)
1997 with the advent of the CDM	Carbon offset market (on the assumption that non renewable biomass could be preserved through ICS projects)	Sustainable development and climate change mitigation (Rosales and Pronove, 2002).	Private companies in partner-ship with host countries and NGOs	Too early to assess	Rarely considered in stove dissemination programmes (Ballard-Tremeer, 2004, as cited in Avis 2004). Methodologies are complex and contradictory. The definition of non renewable biomass should be revised to reflect the reality on the ground.

2000's	BOP concept Private sector interest, compounded by carbon trading opportunities	The Poor are an untapped market	ProBec, Phillips, Bosch-Siemens.	Too early to assess	This entry of private players in the stove arena marks a new age. However, affordability and market development issues remain key issues.

Table 1: Analysis of the foundations and limitations of arguments used in various stove dissemination periods.

Source: Compiled by the author

What transpires from the analysis is that the success of stove programmes is shaped by the target markets' expectations of the product. Also, given that these specific expectations are contextual, the marketing of stoves needs to be differentiated.

People using paraffin stoves for cooking will switch technologies more easily because of the financial offset prospect, whereas people using free wood will be less easily convinced to purchase a stove (Atken, 2009; Stiles, 2009). In South Africa, there is a strong perception that any energy solution other than electricity is sub-standard (Atken, 2009). New off-grid solutions compete against traditionally generated electricity which offers a wide array of services at a minimal cost (Restio, 2009).

The debate on the introduction of stoves for developmental purposes is also underpinned by an inherent contradiction; the impetus to mitigate climate change or improve living conditions does not necessarily match the end-user's direct needs – those of cooking with convenience, at the lowest price possible. Advocating for a technology that would alleviate pressure on forests and climate change is irrelevant if the end product is not desired by the intended beneficiary. The challenge therefore resides in developing a 'win-win' solution, whereby the consumer derives satisfaction from using a convenient and socially uplifting product (Monitor 2009, cited in Kerßenfischer 2009), whilst the surrounding environment also benefits from the

adoption of ‘clean’ stoves. Innovation in product development as well as market research and interaction are needed. As Atken (2009) puts it, “most of the work that needs to be done is on market penetration more than on the production side itself” (pers. com.).

6. *Preliminary results from the pre-feasibility study for wood stove dissemination in the Nhambita research area*

In light of the BOPBOL conceptual framework developed above, empirical lessons emanating from the field research will constitute the base of a discussion on the pre-feasibility of a stove dissemination programme in the research area.

Opportunities and constraints associated with the use of the stoves are discussed through a grid (Table 2) of perceived benefits associated with the arguments outlined in section 3 and inspired from Gupta and Ravindranath (1997). The relevance of these arguments is assessed in the context of Nhambita. It is found that the social functions of the stoves outperform the environmental and economic arguments advanced. As “aspirational products” (Prahalad, 2004), the stoves seem to have, in the case of Nhambita, successfully delivered on the following functions: reduced cooking times, ease of use, cleaner homes, the opportunity to ‘multi-task’, aesthetic appeal of the stoves and the social upliftment implied by those functions.

Benefits grid *(source: Gupta and Ravindranath, 1997)*	Response from Nhambita residents	Relevance of argument for a stove dissemination programme from the end user's perspective
Environmental benefits		
Reduced deforestation and forest degradation	The research revealed that current levels of extraction for fuel wood consumption did not lead to deforestation.	*Medium relevance* The argument is valid but cannot be exploited in the context of Nhambita as part of a carbon offset project
Reduced indoor air pollution (IAP)	Most respondents did not perceive IAP as an issue.	*Irrelevant*
Reduction in use of dung	Only crop residues are used	*Irrelevant*

and crop residues means more fertiliser available for soil	Very few households use fertilizers and no manure is applied to the soils.	
Reduced GHGs emissions.	People are not aware of GHGs issues and do not feel concerned. To them, they are planting trees because they are getting paid and they address the needs of "people in Europe who are running out of oxygen"	*Irrelevant* It is assumed that the biomass is renewable
Economic benefits		
Reduced fuel cost	People do not pay for fuel – all biomass resources are free.	*Irrelevant*
Income generation for stove producers.	Not applicable.	*Irrelevant*
Increased time for income generating activities for stove users	Wood collection is the less time consuming of all house chores.	*Irrelevant* Should a StoveTec project be rolled out in the community, they would be imported and no income activities would be generated
Social benefits		
Improved respiratory and general health	Out of 40 households, only one indicated that smoke constituted a health concern. Fire is not seen as a danger to children either.	*Irrelevant*
Reduced eye irritation	Not applicable	*Irrelevant*
Reduced cooking times	This is highly applicable since women indicated that they spent a lot of time cooking	*Highly relevant*
Less time spent gathering fuel, more time for women and children to pursue other activities; educational benefits for children	Women appreciated the convenience of a stove that did not require so much supervision of the pots whilst cooking. Many women indicated that they often carried out other tasks whilst the food was cooking (taking care of children, tending to nearby fields, etc.).	*Highly relevant*
More attractive and desirable stoves	Women felt a lot of pride in owning a stove, which many visitors came to look at whilst they were cooking.	*Highly relevant*
Ease of use	Women appreciated the convenience if use	*Highly relevant*
Cleaner homes	Women often mentioned how they themselves got dirty whilst cooking.	*Highly relevant*
Protection for community forests	Forest degradation was perceived as a problem but people did not correlate it with possible shortage of supply in the future.	*Medium relevance*

Table 2: Benefits of ICS and relevance of their benefits to the Nhambita context.

Source: Compiled by the author and inspired from Gupta and Ravindranath (1997).

6.1 Identified opportunities

Context specific opportunities identified on the ground with regards to the StoveTec product proposed for dissemination are listed below:

i) Positive response to the product

Out of the 20 households that received a stove, all responded that they were very satisfied with the product. This information would however require follow up field research to assess satisfaction in the long term.

ii) Relevance of the product

The misconceptions, at a design phase, on the functions that three stone fires serve, account for many programme failures. It has traditionally been assumed in the past that people living in rural areas only cook on open fires with same size pots (Karekezi, 1997). Rural households in Mozambique, for instance, typically have an average of four pots, usually one aluminum pot and an average of three clay pots of various dimensions. A stove should therefore be versatile and allow for various sized pots to be used; the StoveTec in this respect responds to the women's needs since it comes with an adjustable metal belt[8] to be fitted around all size pots to increase thermal conduction.

6.2 Identified risks

i) Fire uses and customs

As documented in section 3.5 iii), in the villages of Nhambita, Boe Maria and Munhanganha, men and women would, depending on household set-ups, sit around different fires.

Following the introduction of wood stoves, women kept on lighting an additional open fire next to the stove where the men gather. This cultural dimension in Nhambita puts a question mark on the relevance of stove dissemination programmes in the project area. Emissions from cooking fires would be reduced but would not prevent social fires from being lit and may even cause displacement of carbon.

Preliminary observations of responses to the stoves also indicated that in some instances, the newly introduced stove would be used concurrently with another fire, lit to cook maize powder in a bigger pot. Women's increasing aspirations for convenience in cooking could be a source of leakage (UNFCCC, 2009a).

Another potential pitfall for a stove dissemination project in Nhambita is the 'insect repellent' function that fires serve. It was noted during the field research that cooking fires are most of the time lit underneath an elevated structure (either inside the house or outside the house) where the maize is stored. Farmers suffer significant crop losses due to insect infestation and the smoke of fires contributes to a better preservation of crops. It is therefore assumed that villagers will keep on lighting fires underneath these storing structures. Whether the stoves will still give off sufficient smoke to ensure a similar function would be an important aspect to study in follow-up research.

The heating and social functions of open fires have traditionally been overlooked in stove programmes. 48 per cent of households indicated using the fire for thermal purposes. The StoveTec technical specifications do not indicate that the stoves can be used for space heating. This is a factor which could play against its social acceptance.

ii) Affordability

The Poor's decision to 'switch' to modern technology is conditioned by the affordability of the product in a context of competitive subsistence needs, unreliable revenue sources and a barter-based economy (Bhattacharyya, 2006). The Poor's WTP is informed by very low and irregular sources of income.

Determining the price at which stoves would be sold to households in Nhambita was a difficult exercise. The negotiated outcome was to sell the 'StoveTec' for 200 Mts, which is far below the market value of the stove, estimated at close to 560 Mts (Table 3).

Cost Item[9]	Assumed amounts (US$)	Assumed amount (Mts)	Assumed amounts (ZAR)
Stove out of factory	9.4	272	68
Import duty: 65 per cent of original value of each unit	6.11	177	44.3
Transportation: 40 per cent of original value of each unit	3.76	109	27.3
Total	19.3	559	140

Table 3: Cost breakdown of StoveTec stoves in American dollars (US$), Mozambican Meticaes (Mts) and South African Rand (ZAR).

Source: Author, based on Pers. Com with van Zyl (2009) and Atken (2009).

Field experience in Mozambique showed that StoveTec stoves recipients' WTP averaged 400 Mts, with a few households willing to pay up to 500 Mts. This WTP price is still lower than market costs (560 Mts). Complementary financing mechanisms are therefore required to make such a project viable.

7. Conclusion and Recommendations

This paper attempted to revisit the paradigms embedded in wood stove dissemination since the 1970s. It was found that many of these arguments rested on pre-conceived ideas, and were embedded in the cultural gap between stove projects conceptors and

targeted end-users. These paradigms are questionable either in terms of their scientific rationale (the ‘fuel wood crisis’ argument), or limited in terms of their ability to convince the end-user (the health argument), or methodologically weak (the carbon offset argument).

A key finding is that a clear distinction needs to be operated between sanitary and environmental arguments and those pertaining to the social upliftment of the users. At best, health and environmental benefits will constitute a positive spillover effect from stoves distributed through charity or through the private sector. In any event, engaging with the BOP market implies that the product should meet the expectations of the end user and adequate supporting financing systems identified for the roll-out of the stoves.

Empirical experience - which could not be validated by scientific evidence - from the Nhambita project suggests that the fuel collection habits of forest communities where stoves were distributed as part of pilot research are not putting pressure on forestry resource. The causes of deforestation in this area are mainly due to charcoal production and slash and burn agriculture. One can therefore argue that the cause of deforestation is partly ‘delocalised’ and that trees are being felled to produce charcoal that is hardly ever consumed locally but mostly in the urban centres (Brouwer and Fãlçao 2004; Herd 2007). A stove project in Nhambita could be construed as a preventative measure to slow down forest degradation and to consolidate the gains acquired through *Plan Vivo*. If the merits of promoting such an initiative are certain, such a programme could currently not be supported by carbon finance. The paper argues that it would be more relevant to introduce ICS in urban areas which heavily rest onto their hinterland to satisfy domestic energy requirements.

Alternative financial and distribution mechanisms are suggested below, should the project managers wish to expand the stove project in the Nhambita area.

The possibility of negotiating import duties for ICS as envisioned by Philips (Kerßenfischer, 2009) could make sense, given the very high import duties in Mozambique. Revolving credit is also a worthwhile mechanism to consider, whereby a group of individuals combine their funds to allow one of the members to make a bigger capital investment. Restio Energy (2008) reported that most households where StoveTec stoves were sold in Kwazulu-Natal (South Africa) were bought through local rotating credit associations (Atken, 2009).

In terms of distribution, the socially responsible distribution model developed by Vachani and Smith (2008) could prove of interest. In order to reach economies of scale, the distribution of stoves could be grouped with the distribution of other products. This is in fact what happened with the pilot programme, whereby Envirotrade rented a portion of a truck freighted by a local business man to transport goods from Johannesburg to Chimoio.

By way of conclusion and to further open the discussion, critical aspects with regards to sustainable biomass innovation for the southern African Poor are put forward. The assumptions enumerated below and perceived during the preliminary assessment of responses to stoves should be the object of further research work.

There is a risk that modernized biomass based energy devices, which are postulated to decrease the consumption of fire wood, could lead to an increase of wood consumption given the new services performed by these devices. This rebound effect would result from the observed uses and customs around fire. If the newly acquired stove does lead to a 40 per cent decrease in fuel consumption, overall consumption

patterns may only be mildly altered, given the fact that tradition and strong resource availability leads women to use extensive amounts of biomass. Overall current fire wood consumption in the project area is estimated at 1.62 m^3 per capita (p.c) per annum (p.a)[10]. This consumption pattern falls within the consumption bracket defined by O'Keefe (1984) for African savannahs, which was estimated to range from 1.1 to 1.7 m^3 p.c p.a, but could be rated as relatively high, especially compared to urban consumption patterns. An assumption which would also need to be verified is whether the perceived freeing of biomass through the use of the stoves would not lead households to combust the saved biomass all the same.

Another risk is that the stoves will fail the end-users. The StoveTec has an excellent reputation and was recently awarded the 2009 Ashden International Energy Champion Award (StoveTec, 2009). Stove failure however remains a plausible scenario, especially in a context where the resources for repairs and maintenance are limited, yet not inaccessible.

Stoves could also not be used. Convenience and cultural barriers could not be assessed during field work but they remain plausible. The preliminary findings of the stove pilot project revealed that most households sampled would have not bought the stove if it had been sold at a cost higher than 300 Mts[11]. Fire wood collection regimes and fire wood consumption regimes seemed to indicate that access to wood in Nhambita was an easy and costless exercise. It could therefore be hypothesized that stoves were only used in that location as a pleasant value-add, if made available at a low price. The fact that the villagers got access to the stoves at such a subsidized price hampered any testing of their real degree of 'want' for the stove and therefore any certainty that the stoves will be used effectively.

End Notes

[1] The use of the terms degradation and deforestation can be problematic since degradation indicators vary according to countries. Intense degradation could be construed as deforestation. (Knowles, 2009)

[2] Household consumption should be appraised separately from the commercial use of wood harvested for fish smoking or beer making in Malawi for instance (Benjaminsen, 1997; Abbot, 1999).

[3] In the CDM, additionnality refers to both the financial additionnality (the finance without which the project would not be feasible) and the carbon additionnality (whether the project effectively offsets emissions).

[4] It has to be observed that the introduction of the project altered behaviours with regards to fire wood collection habits. If most respondents indicated that they had always only used dead wood, some indicated that they would sometimes cut live trees prior to the project start in 2003.

[5] At the time of the field research however, the burning of *Machambas* was still taking place at low intensity.

[6] These perceptions pertaining to biomass availability are a clear indication of pressure on local ecosystems. But we also need to take into account the fact that since most the wood that was collected in the *Machambas* has been used and people are starting to stop extending their fields, the impact of fuel wood availability will be immediate.

[7] The correlation between affluence and wood availability is explained by the fact that more labour can be freed up when a household member has a permanent job, which alleviates the pressure of working in the fields.

[8] This metallic belt that is wrapped around the pot was locally named the '*kapulana*', after the Sena word which refers to the long wrap skirts worn by women in the villages. The spontaneous adoption of this term bears witness to the social acceptation of the stoves.

[9] Exchange rate on 20.11.09 from the following source: http://coinmill.com/MZN_calculator.html#MZN=30 where US$1 = 29 Mts and 1 ZAR = 4 Mts

[10] As mentioned in the introduction and in the methodological section, this finding needs to be treated cautiously, as seasonality and abnormal days could not be taken into account because of time constraints. See Annexure for details.

[11] For the purpose of the field trial, stoves were sold at a symbolic cost of 200 Meticais, which is a highly subsidized price and which many respondents indicated was too low. Interestingly, beneficiaries were well aware of minimum cost recovery prices and also underlined that goods sold to them at such a low price had triggered the resentment of their neighbors, who inquired why they wouldn't be offered goods at that price as well. Should the stoves have been handed out at no cost; this would have compounded the problem even more.

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PAPER 2

Do carbon offset projects present a new dimension to the development aid paradigm?

A critical assessment with specific reference to the Nhambita REDD and Agro-forestry carbon offset project, Mozambique.

[Paper to be submitted to the *African Development Review Journal*]

Abstract

The implementation of land use change projects in the framework of carbon offset markets calls for an analysis of the new developmental dimension that such projects bring to decades of developmental aid. By virtue of the market systems that regulate them, such carbon offset projects imply an innovative developmental praxis, whereby project recipients become the sellers of a tangible good in the form of carbon credits. A socio-anthropological analysis of the development projects associated with carbon offset markets, however, suggests that this innovative dimension may be thwarted by the welfare expectations of project participants, as well as by intangible or overt tensions between the developers of the carbon market and the host communities, 'object' of development, which are the intended beneficiaries. Such 'developmental' dynamics may undermine the main intent of carbon projects, which are focused on carbon sequestration through ecosystems conservation and restoration. Empirical evidence was collected from pilot reforestation and avoided deforestation projects in Africa. The research lays the emphasis on the risks and constraints of such projects, from the perspective of the target communities. A key finding of the analysis is that successful forestry projects should ideally be divorced from welfarist interventions.

1. *Introduction*

In climate change circles, there is debate on whether carbon offset markets, in the form of voluntary markets or the United Nations Framework Convention on Climate Change (UNFCCC)'s Clean Development Mechanism (CDM), should focus solely on curbing emissions of Green House Gases (GHGs), or should combine this imperative with other sustainable developmental objectives. The view that carbon offset projects need to translate into sustainable development (SD) is supported by the following arguments:

- Civil society's rising expectations that climate change mitigation interventions should act to reduce social inequalities resulting from climate change (CDM Africa, 2008);

- The fact that SD indicators appear in all compulsory and voluntary methodologies underpinning carbon offset projects;

- The rising interest from carbon credits buyers in projects showing strong SD indicators (Ecosecurities, 2008; Maradan, 2009);

- Ultimately, the success of offset markets is conditioned by the response of recipient communities to these projects. Should a project be rejected by its targeted beneficiaries, its financial viability would be compromised.

This paper seeks to investigate the nature and scope of development attached to carbon offset projects and especially those related to Forestry and Other Land Use Projects (AFOLU) which include reforestation projects and Reduced Emissions from

Avoided Deforestation and Forest Degradation (REDD) programmes. What innovations do they bring in terms of SD, and how do their developmental effects, if any, differ from those of traditional aid?

For the purpose of this paper, development aid is defined as bilateral and multilateral aid, and can refer to either non-governmental or governmental aid. The latter includes both official development assistance (ODA) and official aid (OA)[1]. ODA is defined as:

> Flows of official financing administered with the promotion of the economic development and welfare of developing countries as the main objective, and which are concessional in character with a grant element of at least 25 percent (using a fixed 10 percent rate of discount). … (OECD, undated)

The intent of the paper is not to discuss the effectiveness of aid, as discussed by several authors (Pedersen, 2001; Sachs, 2005; Easterley, 2006 and 2009), but to acknowledge its limitations and to link identified risks and constraints to the developmental aspects of carbon offset projects.

In the context of land-use change offset projects, combining SD with climate change mitigation adds an additional layer of complexity to such projects. If carbon offset projects are expected to improve the livelihoods of recipient communities, they are likely to encounter the same challenges as did development aid projects over the last several decades. This paper argues that in the same way that developmental projects could fail due to oversimplified assumptions on the Poor's needs (Chambers, 1997; Easterly, 2006) and to ill-designed interventions (Moss, 2005), carbon offset projects in developing countries run the risk of coming up against similar impediments.

Further support for this argument is provided by the perception that financial markets on the buying side - that is to say in industrialised countries - are increasingly gaining in maturity and complexity, whilst the supply side of these markets is seriously

deficient (Knowles, 2009), especially in Africa. The failure (Point Carbon, 2008; Maradan, 2009) of African host countries to develop carbon offset projects speaks of the weaknesses of a market aimed at supporting the clean development of emerging countries (UN, 1998:12). It also raises the questions of who benefits most and who really benefits from these projects.

This study attempts to demonstrate that carbon trading constitutes an innovative way of uplifting host countries, by virtue of the new platform of engagement they create between the 'Poor' (the seller) and the 'Affluent' (the buyer). What are the livelihood benefits of such projects for recipient communities? These could range from technology transfer, poverty alleviation, job creation or simply benefits arising from enhanced ecosystems services. These considerations call for the review of recipients' expectations and responses to the changes made to their livelihood strategies (DFID, 1999), through the introduction of land-use changes which completely overhaul ancestral farming practices on a decadal scale. However, Pagiola *et al* (2005) warn that an exclusive focus on poverty alleviation could defeat the purpose and the financial viability of Payments for Ecosystem Services (PES), under which carbon offset projects fall, and which are not to be construed as welfare programmes. Furthermore, SD implies that human development should be embedded within the carrying capacity of ecosystems (Swilling, 2007) which sets a limit to the human benefits from such projects. These arguments call for an inquiry into the sustainable benefits that could be reasonably expected from land use carbon offset projects.

Measuring the long-term impacts of land-use change carbon offset projects proves challenging and the literature underlines the limited case studies available on this topic (Pagiola *et al*, 2005; Jindal *et al*, 2008). This paper attempts to give some

perspective on the risks, opportunities and constraints of such projects. The intricacies underpinning this new mechanism that combines land use changes with environmental conservation and livelihood benefits are debated in the context of private entrepreneurship and global markets.

2. Methodology

Evidence for this paper is mostly based on a review of the literature, stakeholder engagement and expert interviews.

The literature reviewed focuses on the aid effectiveness discourse and on the communal and social responses to development interventions. This later aspect was coined as 'ethnographic development' (Moss, 2005; Easterly, 2006), an approach which offers a lens through which to test the legitimacy of development praxis, from the perspective of the target community. The findings of the paper are also extensively based on 'grey' literature, on the grounds that the views of people affected by carbon offset projects are rarely reported in formal papers. Interviews and workshop reports indeed constitute platforms where the voices of indigenous and local communities can be heard. The expert interviews were mainly conducted with carbon offset project developers.

The paper is also enriched by empirical evidence collected in the rural community of Nhambita, located in the buffer zone of the Gorongoza National Park, in the North-West of Mozambique. Field research on this agro-forestry and avoided deforestation case study was completed during the month of June 2009.

The Nhambita project strives to encourage a culture of farming exclusively on agricultural fields (referred to as '*Machambas*') that were already under cultivation at the onset of the project in 2003. The Nhambita community voluntary entered into an

agreement to preserve the remnants of close to 11,000 hectares of indigenous Miombo woodlands in the buffer zone of the Gorongoza National Park. The communal preservation of indigenous forest through this REDD programme is complemented by individual seven-year contracts entered into with the UK-based firm Envirotrade (Pty) Ltd under the *Plan Vivo* standard. In order to maintain soil fertility and productivity, villagers engage in new farming practices to reverse the leaching and combustion of nutrients resulting from slash and burn agriculture. Participating households are expected to plant and maintain fruit trees to supplement their diets; green manuring trees such as *Cajanus cajan* (pigeon pea); *Gliricidia sepium* and *Faidherbia albida* to improve soils; and indigenous trees to contain erosion and act as wind breakers. In addition to these trees, they receive income generated from the sales of the carbon offsets[2].

The study also refers to the Andasibe-Mantadia Biodiversity Corridor REDD project in Vohimana, Madagascar (L'Homme et l'Environnement, 2009), visited by the author during the month of September 2009.

3 Conceptual framework and literature review

3.1 From post-colonial development aid to carbon offset markets

It is now generally agreed that the 21st century will see a widening gap between the rich and the poor and that emerging countries will not achieve the Millennium Development Goals (MDG) (Easterly, 2009). In the 1980s, development in 'Third world' countries was prominently driven by heavy state intervention. The collapse of corruption-ridden developing states resulted in international bilateral and multilateral donors playing an increasingly important role in the development of emerging countries, especially in Africa (Attwood *et al*, 1988).

The economic assumptions underpinning the World Bank's (WB) and International Monetary Fund's (IMF) engagement with 'Southern' nations have come under harsh criticism (Turner, 1989; Norberg-Hodge, 2000; Stiglitz, 2002). The 'Washington Consensus' is based on the assumption that global economic growth would translate into a 'trickle down' effect; an extensive literature decries how these economic assumptions have permeated development aid approaches and failed to materialize (Norberg-Hodge, 2000). Dresner (2002) deplores the concept of SD as an orchestrated dissimulation of a growth agenda in disguise since the 1970s. He argues that the association between SD and growth has never truly ended, since development is still widely construed as an aspiration to materialistic accumulation and unbridled consumption. From an anthropological perspective, the failure of development aid is explained by the centralised and ethnocentric approaches that have prevailed in the past and which have dismissed recipient communities' ability to act as agents of their own development (Easterley, 2006). The tendency to 'objectify' recipient communities and to accentuate indigenous characteristics have further led to a false consciousness emerging between 'developer' and recipient and undermined delivery on developmental intents (Moss, 2005).

This paper argues that the advent of carbon trading in a context of increasing awareness about climate change possibly constitutes an innovative strategy for development. The United Nations Framework Convention on Climate Change (UNFCCC) was set up in 1992 in response to the increasing evidence that anthropogenic activities are the main cause of climate change (Stern Review, 2006; IPCC, 2007). The primary objective of the CDM is to promote the development and the transfer of clean technologies contributing to the reduction of GHGs with a warming potential, whilst achieving SD (UNFCCC, 2008:1). In 1997, the Kyoto

Protocol supplemented the Convention by setting binding emission reduction targets for industrialized countries ('Annex I' countries), which committed to reduce their emission to 5 per cent below 1990 levels, over the 2008-2012 period. Emission allowances, referred to as "carbon credits", are the products traded on this emissions' trading market.

3.2 Critics of the carbon offset markets

The inequitable impacts of climate change resulted in developmental concerns crystallizing around the issue of climate change, a phenomenon which "weaves a… narrative about its causes, and its cures, that incorporate every issue on the planet" (Klein, 2009:25). Table 1 illustrates the conceptual similarities in the criticisms raised against carbon offset markets (left column) and traditional developmental aid praxis (right column). This comparative analysis of perceived weaknesses does not imply that the arguments put forward are held as legitimate by the author, but it assists with understanding the potential limitations of carbon offset projects in terms of their developmental impacts and of how they are perceived by a portion of civil society.

Nature of criticism of carbon offset markets	**Common Concept**	**Correlation with criticisms of traditional developmental aid**
Carbon markets epitomize a denial of emerging countries' right to develop, whilst industrial nations are absolved from enforcing the industrial changes that would effectively curb emissions (Wysham and Redman, 2009).	Climate justice/ Economic justice	Development may be perceived as a way of expanding markets, which is epitomized by the binding of and conditionality of aid. This practice was theoretically discontinued in 2005 with the Paris Declaration (OECD, 2005).
There is an inequitable geographical spread of carbon offsets credits: India, China and Brazil hold an almost monopolistic place in the generation of carbon credits (UNFCCC, 2008), leaving Africa on the backburner (Bond *et al*, 2009). The focus on these countries follows the direction of foreign direct investments	Financial investments are linked to market opportunities rather than developmental needs.	FDI have been heralded as financial ventures mostly oriented to profit making in emerging economies, whilst largely ignoring local needs (Trainer, 1989).

(FDI) (Point Carbon, 2008).		
Cap and trade is based on the selling of pollution allowances which perpetuate the emissions of GHG causing climate change (Hansen, 2009).	A practice that consolidates the business as usual scenario.	The International Monetary Fund's (IMF) and World Bank's (WB) rigid rules could have contributed to reinforcing the vicious circle of poverty in some countries (Stiglitz, 2002). The contestation staged by civil society during global trade summits is symptomatic of this perception.
Carbon markets are tantamount to "colonial land grabbing" (Bachram, 2008) and carbon schemes constitute "a repressive attempt to create property rights …" (Corner House and the Durban Group for Climate Justice, 2005 cited in Bond *et al*, 2009:12).	Neo- colonialism.	This "colonial land grabbing" argument resonates with the Marxist theory, according to which colonialism equated to claiming property over southern nations. It assumes that the development of industrial nations was only made possible thanks to the under-development of non-industrialized but resource rich countries (Marx, 1867). This Marxist rhetoric also transpires through the argument according to which rich nations force their carbon intense lifestyles onto poor nations.
Carbon trading epitomises the "perpetuation of the commoditisation of nature" (Nengo, 2008:7).	Commoditisation/ Neo colonialism.	The South was commoditised through the exploitation of its people and its resources. Alleged development through "shock doctrine" (Klein, 2007) as it is practiced in a globalised economy is tantamount to a commoditisation of southern economies.
As developing nations bear the biggest impacts of climate change, they will have to forfeit natural and symbolic assets such as the snow on top of Mount Kilimanjaro (Bakamwesiga, 2009:1).	Extinction of cultural symbols.	The African culture and its national emblems are deeply entrenched into community structures which were dismantled during colonial times and the export driven market development phase (Comaroff and Comaroff, 2005).
Citing Fenhann (2006), Bond *et al* (2009) report that renewable energy projects account for 58 per cent of projects, but this only translates into 15 per cent of overall traded credits. Nitrous oxide and hydro fluorocarbons (industrial) abatement projects, which present limited local benefits, make for less than 2 per cent of all projects and yet represent 78 per cent of traded emissions.	Lack of a 'trickle down' effect.	The 'trickle down' rhetoric promoted by the IMF and the WB and according to which poor nations would benefit from global growth has been proven to be limited (Norberg-Hodge, 2000; Dresner, 2002).
Overall, the impact of carbon abatement schemes is limited.	Delivery failure.	A wide literature depicts the failure of developmental aid. In 2006, Easterley

Terre Blanche (2008) reports that in order to remove 1 part per millimetre of CO2 from the atmosphere, 2.13 Giga Tones of carbon need to be offset each and every year. She reports that over the 2006-2008 time period, Certified Emission Reductions (CERs) contributed to offsetting only 0.1 per cent of CO2 emissions.		decried the 2.3 trillion US dollars in aid allocated over the past five years which failed to deliver bare necessities to developing countries such as medication, mosquito nets, etc. (2006: 4). The UN also noted in a 2004 report that development aid could hamper development (UN News Centre, 2004).
In Africa, Petrie (2008) estimates that 1 to 2 per cent of CERs emitted to date in all projects have been deemed likely to make a difference from a SD perspective.	Limited Sustainability.	Lack of lasting success of developmental projects (Moss, 2005).

Table 1: Analytical comparison of criticisms targeting both carbon offset markets and traditional developmental aid.

Source: Compiled by the author

This comparative analysis reflects how socio-economic upliftment endeavours appear to have been biased in favour of the development of economic markets which do not necessarily benefit the intended recipient. In the build up to the December 2009 Conference of the Parties (COP) 15 in Copenhagen, Klein (2009) elegantly linked the issue of "underdevelopment" with the handling of the climate change issue in a market-driven context:

> … the climate is changing not only because of particular polluting practices but because of the underlying logic of capitalism, which values short-term profit and perpetual growth above all else. Our government would have us believe the same logic can be harnessed to solve the climate crisis- by creating a tradable commodity called 'carbon' and by transforming forests into 'sinks' that will supposedly offset runaway emissions (Klein, 2009:25).

Whilst acknowledging these criticisms, the paper will argue that the market underpinning carbon trading constitutes an innovative way of financing sustainable development, as demonstrated by the test case of Nhambita.

3.3 The developmental innovations of carbon markets

The main difference between conventional development programmes and carbon markets lies is the gap between conditional aid and market-related investments. As

Birley, CEO of Envirotrade (BBC, 2009) underlines, the Nhambita project consists of "a new way of doing business". On the one hand, the transactional dimension of the project sets it apart from a charity and its future financial viability depends on the success of this business venture. On the other hand, its benefits are not limited to financial returns (Figure 1), but also include carbon credits and other development benefits (Figure 2).

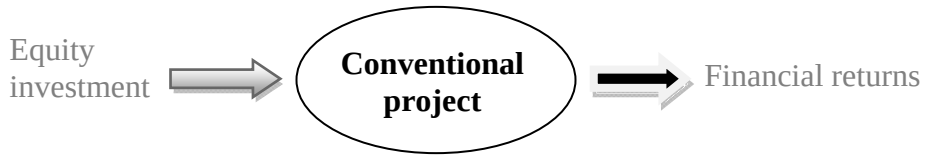

Figure 1: Conventional project investments and outputs

Source: Spalding-Fecher, 2002:13

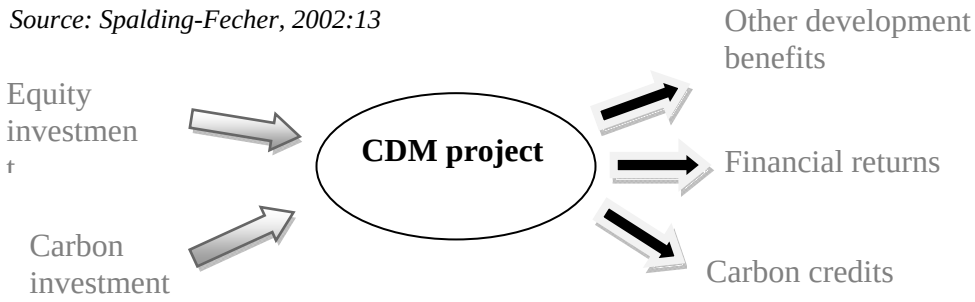

Figure 2: Clean Development Mechanism (CDM) project inputs and outputs.

Source: Spalding-Fecher, 2002:13

The innovative dimension of carbon markets also lies in the fact that developing countries become the owners of a new commodity that they can sell, instead of being solely the recipients of loans or grants (Bauer, 2009). This dimension is summarised in Blignaut *et al's* (undated) statement:

> Those on the demand side and those on the supply side are geographically apart, yet it is in this that the market for ecosystems services can act as a bridge to enable the development of new market opportunities for those who are currently "un-marketed" – those operating in the second economy (Blignaut *et al*.undated:3)

However, empirical evidence and the literature reveal that the SD impacts of carbon offset projects remain difficult to define, let alone to quantify.

Article 12-2 of the Kyoto Protocol states that:

> The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention… (UN, 1998:12)

The notion of SD is not defined in the protocol (Spalding-Fecher, 2002:13) and the Designated National Authorities (DNA) set up in each country to approve of the projects for CDM submission, have the discretion to draw up SD criteria, which can result in weak and inequitable criteria (Olsen and Fenhann, 2008).

In section 4, evidence is put forward to define the risks, opportunities and constraints associated with the developmental aims of REDD and agro-forestry carbon offset projects and which may be reminiscent of traditional development aid praxis.

4. A socio-ethnographic analysis of land-used based carbon offset projects

REDD programmes are premised on the financial compensation of local inhabitants committing to preserve existing native forests. A departure point for an analysis of the impacts of REDD on recipient communities is to understand the conditions underpinning the sustainability of REDD on the ground.

Several challenges put REDD ventures at risk, from the monetary comparative advantage of maintaining forests versus planting energy crops (Wise and Cacho, 2005), to offering viable and lasting alternative livelihood means to the affected people. It is argued that relying exclusively on financial mechanisms to effectively protect forests is reductive and limited (Schmidt, 2009; Schmidt and Ibisch, 2009). To be successful, any REDD programme should be accompanied by "overall development planning (interventions) and engage in providing alternative (at best low-carbon, low-resource) livelihoods" (Schmidt, 2009:8), aspects on which financial

compensation alone cannot deliver. This section sheds some light on these aspects, through a thorough investigation of the Nhambita case study.

The greatest proportion of the Nhambita project's carbon offset activities stem from the REDD component of the project which consists of protecting a total of 11,071 ha of Miombo forest falling under the jurisdiction of the Nhambita communal land, in the buffer area of the Gorongoza National Park. Jindal (2010) reports that REDD activities in the project area have "reduced emissions at the rate of 7.33 tCO_2/ha per annum since 2006, generating a total of 154,457 tCO_2 as REDD offsets" (2010:7).

This REDD component is complemented by an agro-forestry portfolio of activities which generate an additional 1216 tCO_2 per annum (Grace, 2007). Between 2005 and 2007, the project sold 79,658 tCO_2 (Envirotrade, 2008:i).

Envirotrade and its partners have embarked on an ambitious exercise aiming at not only creating alternative means of subsistence for the affected community but also at improving their livelihoods. The benefits associated with the planting of green manuring and fruit trees will only show results in the long term. In the meantime, the income villagers receive through the *Plan Vivo* scheme offsets the effects of the loss of soil fertility and resulting decrease in food production, by allowing villagers to buy food in months of food shortages. The project has also embarked on various initiatives to uplift the lives of the villagers, through the provision of educational and medical infrastructure and through the creation of direct jobs and additional agro-forestry projects such as bee keeping, carpentry, or animal husbandry (Envirotrade, 2008).

Yet, understanding how all these developments are perceived and received on the ground is paramount in undertaking an impact assessment of the developmental dimension of such a carbon offset venture.

4.1 Culturally sensitive development

In his book *The White Man's Burden*, Easterley (2006) condemns the way developmental aid has through history concocted the same "brew of Christianity, civilization and commerce" (2006:159) in the hope of triggering social change. Top down, superimposed models of development from Northern standards onto the South are reported to have little benefits on recipient communities (Chambers, 1997), who are often not truly met or understood:

> Poor people are rarely met; when they are met, they often do not speak, they are often cautious and deferential; and what they say is often not listened to, or brushed aside, or interpreted in a bad light (Chambers, 1983:104).

In his seminal book *The Social Life of Things*, Appadurai (1986) brings in the notion of "tournaments of values" (1986:21), which constitutes a relevant analytical grid when observing the conflicting value systems represented by Western developers and Southern communities, "objects" of development. This tournament can be waged in the form of coercive conquest wars, or as depicted by Moss (2005), by the recipients' pretending to embrace indigenous values or behaviours to steer the development project in their favour.

These different value systems are apparent in the way that the object of trading is perceived: for project developers and the downstream purchaser of carbon credits, forests are merely a commodity able to store carbon, units of which have a pecuniary value. By contrast, people who rely on these ecosystems for their livelihoods entertain a cultural and spiritual relationship with them (Nengo, 2008), although they are also the ones engaging in destructive behaviour, such as charcoal making and slash and burning agriculture, to eke out a living.

West (2005) borrows Cameroonian historian Mbembe's archetype of "language of power" to convey the different languages that Mozambicans had to adopt throughout the last five centuries of their interaction with the "Other", who is not necessarily the white man. He chronologically enumerates the several languages of power in which Mozambicans have become conversant with the "Other":

> … the language of the slave trade, the language of Portuguese colonialism, the language of revolutionary nationalism, the language of scientific socialism, and, finally, the language of neo-liberal democracy (West, 2005:3).

If West (2005) anchors his findings in the reality of the people living in the northern Mozambican Muedan plateau, the metaphor can be extended to the Nhambitans' recently acquired fluency in the language of carbon trading, the latest manifestation of neo-liberalism. As West (2005) points out, the "vacuum created by a receding state" (2005: 22) in a post civil war context, has created fertile ground for the exponential growth of private interests benefiting both domestic and international investors. This post-war economic boom, of which carbon trade project developers backed by international funding form part, unequivocally results in increasing "economic differentiation" (West, 2005:34). This differentiation is perceptible in the Nhambita community, where villagers are seemingly divided between the households who have entered a contractual agreement with the project (locally referred to as '*o projecto'*, in Portuguese) and those who do not have a contract yet, or who have breached it. Underlying this first layer of economic dualism inherent to a carbon offset project, emerges a second level of economic differentiation between the households which have a family member employed by the project, and those who haven't or who's member left or was dismissed by the project. Field research revealed that individuals who have a permanent job with the project are perceived as benefiting far more from it than the majority of villagers who solely perceive proceeds from the carbon finance scheme. Interviewees indicated that the wealthiest in the community, who could

afford a cell phone, corrugated iron roofs, a radio or even solar panels, were all permanent employees of the project. Recipients' relationship to the project manifested through a willingness to engage with the "Other" and to benefit from arising opportunities. Frustration, if not resentment, were perceptible from those who were seemingly excluded from the project's most gratifying aspects.

We could thus agree with West (2005), in that Nhambitans experience such "neoliberal 'development(s)' with deep ambivalence, longing for the 'modern' objects that have appeared in their midst while sensing that all these objects remain inaccessible to them" (2005:192). West in this instance specifically refers to government-sponsored agricultural vehicles which benefited an elite of influential FRELIMO Muedans during the civil war and who were also masters of "*unwavi wa kushunga* – (the) sorcery of self advancement" (2005:188). By the same token, verbal resentment was expressed in interviews against Mozambican project managers who had seemingly acquired external signs of wealth through their association with the project.

Carbon offset projects will have a powerful and lasting impact on recipient communities but this impact is likely to be inequitable and to benefit individuals in a heterogeneous manner. In order to avoid raising expectations which cannot be met, an alternative model for AFOLU projects of this nature could consist of restricting interactions with the community to the strict ecological intent of a REDD or reforestation project, thus limiting the potential negative –but also positive- socio-economic impacts of such projects. This approach was upheld in another project developed by Envirotrade in the Zambezi area (MacCrimmon, 2009).

The perceived upliftment accompanying such projects can possibly be disruptive to local communal cohesion. This raises the question of whether disturbance to local socio-economic fabrics resulting from carbon offset projects are ineluctable.

4.2 The commoditization of cultures, a prerequisite for development?

The carbon industry has fallen under harsh criticism for epitomizing the battle on the "right to the sky" (Stilwell, 2009, as cited by Klein, 2009b). The commoditising of nature is pushed a degree further when the developmental agenda of carbon offset projects results in shaping the aspirational wants of recipient communities.

Comaroff and Comaroff (2005) render a gripping account of how 19th century missionaries in South Africa acted as key drivers of the commoditisation of African "land, labour and produce" in their endeavour to pull the heathen out of the "fountain of African misery" (Livingstone, 1940, as cited by Comaroff and Comaroff, 2005:157). Incorporating the southern Tshwana "natives" into this economic revolution entailed monetising a trading system which traditionally relied on the trading of beads and the ownership of cattle, that the Tshwana were reluctant to part from. It appeared that they valued the intrinsic social status associated with their ownership rather than their trading value, much to the dismay of white settlers willing to buy cattle. Subduing the Tshwana to currency not only served the purpose of creating some "exploitable dependency" in the form of labour and to making them receptive to Christianity. Their evangelisation also led to a culture of saving, which resulted in increasing their aspirations to also own the plethora of objects that the missionaries brought in their wake.

This "domestic reconstruction" described by Comaroff and Comaroff (2005) presents relevant similarities with the Nhambita project. In the same way that the sudden

availability of goods such as furniture, blankets and clothes sparked off a deep mutation in the "complex array of wants" (2005:159) of the people, some Nhambitans also developed consumerist aspirations which they could finally afford thanks to the capital inflow into the community. Accounts of the sudden introduction of money in forestry villages of Cameroon during the early 20th century rubber boom also relate how deeply it transmuted societies based on a kinship gift and marriage exchange economy (Geschiere, 2005). The sudden inflow of money into the forest villages as from the early 1930s violently eroded the social structures of the Maka forest people, swiftly putting "up everything's for sale" (2005:247).

An aspect which would require further investigation is how Nhambitans made use of their recently acquired wealth. Interviews revealed that money obtained from carbon income was mostly used to purchase food and clothes, to pay for school fees and in some instances to upgrade houses. Informal discussions and anecdotal evidence also suggested that the growing consumption of alcohol by the villagers accounted for a noticeable portion of the money spent. In their description of how the introduction of alcohol harshly damaged the social fabric of 19th century Bechuanaland, Comaroff and Comaroff (2005) herald alcohol as "the most profitable and addictive of commodities". To the authors, it epitomizes the "desire to make 'natives' dependant on the market" (2005: 162). One of the stores which were originally opened in Nhambita sold alcohol. At the time of the field research, Management had decided to discontinue the selling of alcohol in the village, as a result, one could assume, of the negative impacts this trade was perceived to have on the local community.

Considerations on the impacts that carbon offset projects have on recipient communities require taking stock of the repercussions they have on the social fabric

of a given community. Project developers on the ground should not be oblivious of the acculturation continuum they form part of, since any developmental endeavour, especially if associated with a "Christian political economy" (Comaroff and Comaroff, 2005:167), appears to be rooted in an ideology. The Nhambita project has unequivocally improved the livelihoods of nearby villagers who now have better schooling opportunities and medical assistance; one may argue this was at the cost of a fragile acculturation.

4.3 From low to high intensity: responses to prescriptive ways of interacting with resources

Preventing communities from cutting down trees pertains to prescribing new ways of living, which are often in contradiction with ancestral traditions. Therototically, the Nhmabita community consented to protecting their forests and a communal agreement was entered into with the Project managmenent structure. The research aimed at unveiling how the project recipients have responded to these new 'life styles'.

It is challenging for lay people to grasp the nature of the abstract entity they are 'producing' for the carbon market. Local communities in Nhambita and Indigenous communities in Africa in general (IPACC and CI, 2008) find difficulty in fathoming firstly why people would want to pay to protect their forests, with some indigenous representative expressing how scary he found the prospect that their forest could the object of an international 'deal' (IPACC and CI, 2008). Secondly, understanding the carbon cycle and the nature of the good traded is also delicate. Asked why he thought he was being given money for planting and keeping trees alive on his *Machamba*, an old man responded: "Because they are running out of oxygen in Europe" (Interviewee, 2009). Lastly, expecting local communities to take part in tree planting

can prove to be testing; Sera (2009) reports that at the onset of the Nhambita project, some villagers were reluctant to plant trees, deeming that this was “God’s job”.

A REDD project implies that new agricultural fields cannot be opened and it therefore deeply affects the traditional ways of farming locally. REDD signifies that villagers living on the periphery of forests need to adopt sedentary agriculture practices in a shift away from itinerant slash and burn farming practices (Envirotrade, 2008).

At the time of the field work, conflict between a small group of “dissident” members of the village and project management manifested in sporadic burning of forest sections. An interviewee reported that “they are burning the forests to expand their Machambas” (2009, pers. com.). Speculation was rife regarding the motivation behind these recent slash and burn activities banned by the communal agreement[3]. The most immediate reason points to the need to expand farming land for agriculture production. Several respondents indicated that especially their maize productivity had decreased as a result of the moratorium placed on the opening of new *Machambas*. A woman (2009, pers. com.) indicated that her income would be far greater if she could plant a new field to a cash crop such as sesame, which promised higher returns than the money received from the project. But the voluntary undermining of the project following a personal feud with the project also appears as a plausible scenario (Anonymous, 2009). Accounts of the mediation that then took place between the perpetrators and project management relate the entitlement felt by those who had opened new fields to do so. The perpetrator was reported to have recalled the past independence war fought against the Portuguese to advocate their ancestral right to slash and burn (Goss, 2009). A participatory rural appraisal session with male community members allowed the researcher to map and date the occurrence of eight

intentional fires in the forest between 2006 and 2008 (see map 7, annex 5). Such acts of defiance are not restricted to this project and certainly do occur in other carbon projects. In Madagascar, a technician of the Vohimana project managed by the *L'Homme et l'Environnement* Non Governmental Organisation related how farmers would open agricultural fields ("*taves*" in Malagasy) in the heart of secondary or primary forests which are not visible to project managers.

Such responses are anchored in the fear of forestry communities that the implementation of REDD projects implies the exclusion of people from forests, in reminiscence of the "fortress conservation" period (Hulme and Murphree cited in Salomão and Matose 2007), when national park boundaries were defined from the 1960s to 1980s (Bass *et al*. 2000). A second wave of disenfranchising which would further deprive forest communities of their consumptive traditions of timber and non-timber forest products is posited as the greatest threat associated with REDD projects. These fears have been readily expressed in all consultation platforms between the World Bank's Forest Carbon Partnership Facility (FCPF) programme and indigenous people (IPACC and CI, 2008; Nehue 2008; Personal communication with members of IPACC, 2009). Examples of displacements of indigenous people for the creation of National Parks include the Batwa people in Rwanda, Cameroon and in Burundi (Couillard *et al*, 2009). An emerging literature depicts the adverse effects of forest-based carbon projects on forestry communities, such as the commercial plantation project in the Bualeba Reserve in Uganda, which excludes communities from exploiting resources (Eraker, 2000 as cited in Jindal *et al*, 2008).

Beyond altering the socio-economic fabric of an affected community, AFOLU projects effectively imply that these communities are prescribed a new way of living,

which can have destructive impacts on their livelihood strategies. If such projects are not owned by the community and implemented from within, they are likely to be met with strong resistance.

5. Risks, opportunities and constraints of REDD projects' development aims

5.1 Challenges to community-based forestry management

It was through the 1997 New Land Law that the Nhambita community pilot project in 2002 claimed the management of natural resources, in association with government and private business (Fãlçao *et al.* 2006 as cited in Herd, 2007). According to this agreement, the community is entitled to farm, make charcoal, fish and hunt (Envirotrade, 2008). Villagers are allowed to collect dead fire wood and live wood for private use. This regulation of wood usage is generally respected within the community (Jacobe, 2009). All wood extraction for commercial purposes requires a permit by the Ministry of Agriculture, which was granted to the community-based carpentry project that is being effectively operated by Envirotrade (Goss, 2009).

Coleman and Steed (2009) reflect on the best ways to monitor and sanction the exploitation of Common Pool Resources (CPRs). The CPRs considered in Nhambita are forestry CPRs. They establish a correlation between strong community-based monitoring and sanctioning with harvesting rights and with community members' degree of "residual claimancy" over those resources. In other words, the more interests the community has in "all rewards and benefits accruing from a resource that are not captured by other resource users" (2009: 2107), the less likely they are to plunder these resources. The residual claimancy of Nhambitans over the forest excludes the exploitation of live wood and pertains to ecosystem services and more immediately to the financial reward attached to forest conservation (REDD). As

mentioned earlier, some villagers who fell in disgrace with the project are effectively excluded from this pecuniary dimension of CPRs, since they no longer receive payment from REDD (Ranguisse, 2009). The individuals who continue slashing and burning therefore have no residual claimancy to the forest, that is to say no financial incentive to take part in its conservation, and they may effectively gain more from planting commercial crops. One anonymous respondent (2009) indicated that this situation was far more suitable to him, since he could act as an independent entrepreneur instead of having to follow the instructions of an external agent.

The opening of new fields may be perceived as acts of mutiny by project management, thus triggering a precarious shift in the nature of the interaction between locals and project developers. In such an event, the corrective response to adopt raises sombre ethical issues. Who is responsible for sanctions, if any? Jindal (2010) indicates that following the opening of new fields in 2006, payments to the responsible contracted households were withheld in 2007. The perpetrators of the burning were then expected to repair the damage by rehabilitating the affected forest. Although the physiognomic characteristics of Miombo woodlands and the seasonality of fires make some Miombo species resilient to fire (Trapnell, 1959 and Lawton, 1978, as cited in Zolho, 2005:30 and 2005:54), full recovery, which depends on many factors such as topography, soil moisture and seasonality, would still require several years. Fires will affect not only woody plant density (Trapnell, 1959, as cited in Zolho), but will also impact on the long term productivity and population structures of a species in their associated ecosystems (Frost and Robertson 1977 as cited in Zolho 2005:34).

Citing Stern *et al*. (2002:462), Coleman and Steed (2009) note that successful CPR institutions "are widely recognised (as) depend(ing) on the ability of users to… sanctions rule breaching behaviour". Determining how successful the project is in this respect was not the focus of the research but evidence gathered in the field suggests that the effective monitoring and sanctioning is carried out by few individuals, namely the forest guards and the forest technicians, who would appear to have more of a residual claimancy to CPRs, since their livelihoods depend on the resilience of these CPRs, the project being their 'employer'. This aspect may answer the question raised by Boyd and Matthew (2007) as cited in Coleman and Steed (2009): "Why do those who monitor and sanction engage in such behaviour at a personal cost to themselves?' (2009:2107). Shortly before the field visit, one of the forest technicians was violently assaulted for having denounced someone who had illegally opened a field (Ranguisse, 2009). It can be assumed that he did so to retain his job, an incentive that all other villagers do not have. As confirmed by Jindal (2010), a large portion of the REDD income is allocated to paying the wages of people who patrol the woodlands and monitor fires.

Another important point to raise in this respect is whether income amounts received constitute a sufficient incentive to prevent local inhabitants from encroaching on local forestry resources. Annual payments for the conservation of the Miombo woodlands are made into a community fund (Envirotrade, 2008), on top of which individuals receive an individual amount. Interviews revealed that 62 per cent (n=21) of community members found carbon income received from personal contracts below their expectations. According to information collected during interviews, the average income received by contracted households in the first year amounted to 1,500 Meticaes (Mts) (US$51)[4] (n = 19), to Mts 624 (US$ 21) (n=18) in the second year and

to Mts 538 (US$18) (n=12) in the third year. These figures differ from the amounts found by Jindal (2010), who estimates that between 2007 and 2008, participating households received on average 1,923 Mts (equivalent to US$80) (2010:11). The size of the sample use in the research cannot permit a definitive conclusion and time did not allow for the information collected from interviews to be cross-checked, but this raises an important point in terms of perceptions around the carbon income received. It is also important to note that since households receive 30 per cent of overall income in the first year, the time at which this information was gleaned within the 'cycle' of the contracting period may influence the results. As stated earlier, reinforcing the financial value of forestry CPR is paramount to making REDD viable. It could thus be argued that even though investments in community infrastructure make sense from a developmental perspective, the primary objective of REDD is forest conservation and individual carbon income should be increased.

The observed lack of understanding from recipients as to why they were receiving far less money in the second year of contract or why they had not received any income calls for extensive and systemic communication on how contracts are structured.

Some respondents expressed their willingness to be more involved in deciding which types of contracts they would like to take up and the time of the year when they receive the trees, since planting trees in the rainy season greatly improves chances of survival. The managers of the *Scolel Té* project in Mexico, one of the first voluntary forestry based carbon offset project on the market, link the strong uptake among local farmers and its low desertion rates to the fact that project implementation is shaped by the participants. They design themselves the agricultural *planes vivos* ('working

plans' in Spanish) that they want to adopt and from which they derive revenue (Wunder and Vargas, 2006).

From a gender perspective, contracts are structured in such a way that payment accrues to the "owner" of the *Machamba*. Jindal (2010) found that female headed households regarded *Plan Vivo* contracts as a valuable source of cash income. But in the case where contracts are awarded to women who live with their husbands, gender inequalities may arise. In several instances, women complained that they were the ones planting the trees and adhering to the new farming protocol, and that their husband received the income from contracts. Some women did not know how much they were receiving from these contracts.

5.2 Structural challenges

Carbon investors do not have control over all the factors determining the success of REDD ventures. Unclear land tenure rights, combined with population increases, constitute structural challenges that could put REDD projects in jeopardy.

Scholars have referred to the African land tenure system as being in a state of "crisis" (Nengo, 2008). In many modern African countries, customary tenure rights have been discarded in favour of exclusive state ownership, which is the case in Mozambique (Salomão and Matose, 2007). The lack of clear tenure arrangements in Africa is a key challenge to carbon investments; investment in communally-owned land such as in the case of Nhambita is posited as a suitable alternative (Jindal *et al*, 2008). In Nhambita, the local leader, the *Regulo*[5], would traditionally allot land to new comers to the project area for subsistence farming; this piece of land thus de facto becomes privatised (Jindal, 2004). The respect of this basic right, combined with an increasing

influx of new comers to the project area, constitutes the greatest threat to the viability of the project.

Scholes (1996) draws attention to the potential adverse effects of demographic trends in Central Africa, where the pace of population growth overhauls that of economic growth. This situation is also foreseeable in Nhambita, where the mean average population growth in the area is estimated to reach 5.87 per cent (Tipper and Grace, 2008), compared to the country average of 1.79 per cent (CIA 2008, as cited in Tipper and Grace (2008:163)). Tipper and Grace (2008) found an increase in the number of people per household from an average of 4.2 people per household in the late 1990s to 5.1 people more recently (2008:162), which is congruent with the average of 5.2 people per household found in the field research. They estimate that an average of 3 to 5 households per annum have settled in Nhambita from 2003 to 2008. It is uncertain whether the project will be able to absorb such a growth of population.

The food requirements of a soaring population will most probably deeply affect the ecology of the Miombo woodlands and alter the Miombo *status quo*, characterised by "low soil fertility, lack of infrastructure and the presence of diseases", features which up to now had "preserved the Miombo" (Scholes,1996:13). Agricultural progress and infrastructure development will, according to Scholes, translate in more fields being cultivated but with insufficient outputs; additional forest clearing will be the response to the population increase, thus precipitating climate change.

Among the factors that may exacerbate pressure on forests, are the potential increase in charcoal production (Herd, 2007), increase in wild fires and in-migration which would be the result of better amenities being brought to the area[6], but also the job opportunities associated with the carbon project. Another question which remains

open pertains to the future occupation of Nhambitans' children. In interviews, some parents indicated their intention to subdivide their *Machambas* between their children, which begs the question of land availability in an area where agricultural activities are now contained.

The influx of outsiders could also negatively affect the project in terms of monitoring and sanctioning. Leach and Mearns (1988) emphasise the correlation between the resilience of a long-established community which has known little in-migration, with the effectiveness of community sanctions. The increasing number of outsiders in Nhambita raises the question of whether these dynamics will in future be disturbed.

5.3 Livelihood benefits

Assessing the effective livelihood benefits of the project is not the object of the paper and it may be premature to assess its long-term benefits. The project's engagement with the villagers and its willingness to create as many collateral benefits and genuine employment opportunities was commended by independent reviewers (Niles, 2008). However, as Pagiola *et al* (2005) emphasise, assessing the benefits of REDD programmes in terms of poverty reduction may be the wrong question to ask. To them, the primary functions of a PES project are the effective delivery of environmental services and the project's financial viability, rather than its welfare impact, else these projects might defeat the market rational that underpin them. Another key parameter to define the success of the project is the agricultural benefits associated with these new practices (Wise and Cacho, 2005). Nevertheless, valuable lessons heralded from practitioners and the literature can be put forward at this stage.

5.4 Equity issues

Not all households have an equal access to a PES project. In Nhambita, participation appears to be limited by the project's capacity to absorb new entrants. It was found that participation was mostly conditioned by kinship ties and physical vigour to undertake the task of planting and watering trees. The isolated elderly, who are more marginalised from community events and who are no longer physically able to plant trees (Interviewee, 2009) are more likely to be excluded. Furthermore, anecdotal evidence revealed that those who had the most land benefited more from the project, since a greater surface area could be planted, or since their property included woodlands.

Secondly, the stark discrepancy in revenues received from carbon payments and income generated from a permanent job in the micro-entreprises can be construed as a source of inequity. Over the 2007-2008 time period, employed staff received an average annual salary of Mts 12,484 (US$519) (Jindal, 2010:11). This is on average 6.4 times greater than the income perceived from carbon finance by participating households.

5.5 Permanent jobs versus carbon finance versus agricultural benefits

Asked about the best aspects of the projects, people responded that these were, by order of importance: 1) the creation of permanent jobs; 2) public infrastructure 3) carbon finance and 4) the provision of coffins for the deceased. These responses elicit strong expectations from the project, in terms of economic upliftment and in terms of charitable public benefit.

If the creation of alterative livelihoods principle (Schmidt, 2009) is endorsed as a prerequisite for such REDD ventures, these alternative livelihoods cannot all be supported by a permanent job. The Vohimana REDD project in Madagascar also makes provision for welfare activities, combined with job creation interventions, such as a distillery, eight nurseries and eco-tourism activities. However such activities would create a few tens of jobs and could not provide alternatives to all forest villagers (Ramarolahy, 2009). The biggest challenge for making REDD viable therefore resides in defining functional and lasting alternative farming systems to counter fertility losses associated with avoided deforestation interventions. REDD projects rest far more on alternative agro-forestry activities than on alternative livelihood opportunities.

5.6 Environmental benefits versus Individual benefits

The success of the Nhambita project is to be measured in terms of its environmental impacts. Payment is conditioned by the degree to which the contracting party has succeeded in rendering the environmental service, through the planting of trees. Performance indicators are thus additional carbon offsets. The beneficial spill over benefits on the village is thus seen as a secondary priority. Bass *et al* (2000) highlight the fact that cash income from carbon offset revenue cannot constitute a full substitute to the natural resources accessed by rural communities and can merely act as a supplement (Bass *et al*, 2000).

The findings of Wise *et al* (2005) second this view. They modeled the financial implications of switching from a continuous cropping system to an agro-forestry system. The model is based in the Indonesian context but the parameters are relevant to Nhambita, since the agro-forestry model runs over 25 years of intercropping

Gliricidia sepium, also used in Nhambita, together with maize[7]. The authors found that this switch often resulted in higher costs than gains for the individual landholder and that:

> … Approximately 22% of the economic benefits obtained by switching land use were attributed to carbon trading and the remaining 78% were attributed to improvements in land productivity (Wise *et al*: 2005:1).

Increased agricultural outputs appear to be the major tangible SD outcome to be expected from the perspective of the recipient. Most respondents did not recognise the benefit of the trees offered to them and complained of the little rewards they received for so much work[8]. Information and education are thus paramount to make recipients understand that the project is primarily meant to benefit them from an agricultural perspective, rather than laying the emphasis on monetary gains (Ramarolahy, 2009).

6. Conclusions

As with any developmental projects, carbon offset projects fall subject to the "possibility of exposure and disgrace" (Li, 1999:299, as cited in Moss, 2005). The marketing of the offset project actually enhances scrutiny and therefore the vulnerability of such endeavours. As Moss (2005) elaborates, "claims of success are always fragile and counter claims about developmental outcomes (are) 'points of political leverage'" (Moss, 2005:7 citing Li). The project conceptors and implementers of the Nhambita community have willingly opened themselves to scrutiny and are not immune to controversy - or 'disgrace' (Moss, 2005) - stirred by external parties (Gillard and Olden, 2009). The Nhambita project is a pilot experiment from which valuable lessons can be learned in terms of project management and in the dialogue with recipients.

The study attempts to identify stumbling blocks to carbon offset projects which mirror misconceptions and mistakes which characterised decades of developmental practice.

It is acknowledged that if SD should intrinsically form part of REDD projects - now often referred to as REDD+ because of the improved forest management techniques that these project imply (Carbon Positive, 2008) - the primary impetus of such carbon offset projects is to alleviate anthropogenic pressures on local ecosystems. This is made possible through the income generated from the sale of carbon credits, but mainly from improved farming practices.

In terms of project design and management, it can be asserted that:

- Excluding members from CPRs may result in aggravating adverse responses to the project, since these individuals are no longer residual claimants of forestry resources.

- Increasing monetary benefits from REDD and *Plan Vivo*, even at the expense of a community fund, could better serve the interests of such projects.

- It can be argued that REDD projects which are more withdrawn from the community and its inherent welfare expectations, could be a viable alternative to the Nhambita model (MacCrimmon, 2009).

- Information and education accompanying project roll out is essential to not create deceptive expectations from such projects.

- These points emphasize the need to ensure that local inhabitants have ownership of the project. They should be the architects of their own development rather than the objects thereof.

- It was also demonstrated that the quality of the developmental outcome is conditioned by the nature of the interactions between developers and recipients of development. In this respect, an ethnographic approach, as discussed in section 3.1, should permeate the ideology of carbon offset projects (Moss, 2005).

The next challenge for the Nhambita sub regional project will be its integration into a nation-wide REDD approach (Niles, 2008), when REDD hopefully becomes officially endorsed by the UNFCCC in 2010

End Notes

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[1] OA refers to funding meeting the same requirements as ODA, except that this type of aid is allocated to countries in transition (Part II listed countries) (OECD, undated).

[2] These carbon offsets are the product of carbon sequestrated in individual households and in communal forests. Income generated from the REDD project is allocated to a communal trust fund. For more details on the project, see http//:www.envirotrade.net.

[3] It was interesting to note that respondents referred to the moratorium on slash and burning as the "decision of the project", rather than the voluntarily agreement entered into by the Nhambita communal body.

[4] This was the exchange rate on 20.11.09, from the following source: http://coinmill.com/MZN_calculator.html#MZN=30 where US$1 = 29 Mts.

[5] The *Regulo* is represented by the *Mfumo* in different sections of the village.

[6] At the time of the research, a major electrification of the project area was under way.

[7] Maize constitutes, together with sorghum, the staple diet in Nhambita.

[8] There is little irrigation infrastructure in Nhambita, so all the watering of trees is done manually.

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CONCLUSION

The research has shown that if carbon offset projects - in the form of ICS programmes or AFOLU programmes - make sense from an environmental perspective, their implementation on the ground may still be hampered by significant cultural and social barriers. This epitomizes the potential conflict in defining sustainable development priorities from the perception of project developers and that of recipient communities, whose reality is shaped by vulnerable and versatile livelihood strategies. There is also a risk that carbon offset projects rest on misconceptions of communities' energy needs or on their interactions with their local environment, which could further compound the risk of project failure. Any climate change mitigation or adaptation strategy which calls for the adoption of new technologies or new farming practices will depend on local inhabitants' willingness and ability to alter their livelihoods.

Of prime importance is the need to communicate extensively with local communities as to the purpose of the project, whilst bearing in mind that the buy-in from target communities is ultimately conditioned by economic and social rationales. In other words, a carbon offset project's success on the ground will be enhanced by strong financial benefits and the provision of elements of livelihood alternatives. Whether such projects should by be accompanied by welfare benefits in the form of physical or monetary capital (DFID, 1999[6]) is questionable, since such an approach may undermine the viability of the carbon venture.

It may be premature to answer the questions raised in terms of who benefits and who benefits the most. Benefits are better measured in the long term and assessing the root

[6] See DFID reference in Paper 2 Reference list.

cause of positive or negative outcomes is a testing exercise. Many parameters can impact on rural communities in the South and the impact of carbon offset projects is difficult to isolate from other developmental interventions that run in parallel to these projects, or from other macro-economic indicators which such projects cannot influence. The management of carbon offset projects is by nature very strenuous and absorbs a significant portion of carbon income.

Further research on the topic is called for. A broader consultation process, beyond satisfaction surveys conducted with project recipients, on how the process could be improved in order to positively influence behavioural and social change would be a valuable exercise.

ANNEXURE

ANNEX 1: JOURNALS' INSTRUCTIONS TO AUTHORS

Climate Policy submission guidelines

Climate Policy presents the highest quality refereed research and analysis on the policy issues raised by climate change, and provides a forum for commentary and debate. It addresses both the mitigation of, and adaptation to, climate change, within and between the different regions of the world. It encourages a trans-disciplinary approach to these issues at international, regional, national and sectoral levels.

We are pleased to announce that Climate Policy has recently implemented a web based submissions and peer review tracking system, ScholarOne Manuscripts. Having an online submissions site facilitates the rapid upload of papers, and allows authors to keep track of their papers' progress through the editorial process.

Guidance for Authors Source http://www.earthscan.co.uk/Default.aspx?tabid=482

1. Creating an Account

In order to submit a paper for consideration in Climate Policy, you must first register an account on the Climate Policy ScholarOne Manuscripts' site. To create an account, go to the following website: http://mc.manuscriptcentral.com/cpol and click on the 'Register Here' link. You will then be given step by step instructions on how to register. Authors will be asked to provide their contact details and other relevant information to be held in a private online database. Authors and referees have the right to opt in/opt out of receiving marketing from Earthscan (Climate Policy's publisher) and Climate Strategies (a sponsor of the journal).

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Papers for consideration should be uploaded electronically to Climate Policy's online submissions site http://mc.manuscriptcentral.com/cpol to facilitate a rapid editorial process. New users must first create an account. Authors will be asked to provide their contact details and other relevant information into an online database. Authors and referees have the right to opt in / opt out of receiving marketing from Earthscan (Climate Policy's Publisher) and Climate Strategies (a sponsor of the Journal).

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The preferred file format is Microsoft Word or RTF. Please do not submit your documents as PDF files as ScholarOne Manuscripts (formerly known as Manuscript Central) will automatically create a PDF for the purposes of refereeing. Please refer to the requirements on Type of Contribution, Language and Style, Manuscript Preparation and Layout - described below. If an author is uncertain about whether a paper is suitable for Climate Policy, it is acceptable to send a synopsis first to the Editorial Office: climatepolicy@imperial.ac.uk.

As part of the submission process, authors are requested to submit full contact details for three potential peer reviewers of their manuscript. The nominated reviewers must have expertise in the field relevant to the paper and be independent of the author, the research project and the institutions affiliated with the research. The Editorial Office

will exercise its discretion in deciding whether to use some, none or all of the suggested referees and may also add other referees. All articles undergo a rigorous double-blind peer review process before they can be considered acceptable for publication.

Authors and referees will also be asked to notify the Editorial Office of any potential or perceived conflicts of interest.

Once an article has been successfully submitted, it will be allocated a unique reference number. Authors should use this number in all subsequent correspondence. Failure to do so could result in delay in the processing of your article.

As Climate Policy uses a double-blind refereeing system, it is essential that the document does NOT contain the author's name, affiliation or any distinguishing marks of identity on it. The author must also ensure that the name or address of the institution where the research was undertaken is not included in the manuscript.

The author's acknowledgments should NOT appear on the submitted manuscript. Contact details, institutional affiliation, and acknowledgments can be added upon acceptance. Further guidance on acknowledgments is provided in Manuscript Preparation and Layout below.

Only those papers receiving favourable recommendations from the referees will be accepted for publication. A final decision about whether to accept a paper is made by the appropriate editor.

Authors should keep a copy of their articles and illustrations. While the editors, referees and Publisher will take all possible care of material submitted to the Journal, they cannot be held responsible for the loss of or damage to any material in their possession.

Types of Contribution

There are a number of categories for articles. Authors need to be aware of the scope and length (word count) before selecting an appropriate category. The peer reviewed categories are:

- Research articles (4000–6000 words) present high quality research

- Synthesis articles[7] (6000–8000 words) present a survey and synthesis of the state of knowledge and key issues in a particular area of relevance to climate policy (including scientific, economic, environmental, institutional, political, social or ethical issues)

- Policy Analysis articles (1000–3000 words) present evidence-based objective analysis of policy that is embedded within an existing literature and context

In addition, Climate Policy publishes lightly peer reviewed essays (commentary articles on current events, issues, and previous publications), book reviews and relevant information on legislation and agreements:

- Outlook: Perspectives (500-2500 words) are invited contributions from senior decision makers

- Outlook: Insights (500- 2500 words) are from independent commentators on policy processes, positions, options and debates

[7] I will submit my paper as part of a synthesis article.

- Outlook: Records presents information on important new agreements, legislation and other developments including analysis of key events

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- Outlook: Book Reviews (1200-1800 words) are commissioned by the Book Review Editor

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Articles should be in English and should be written and arranged in a style that is succinct and easy for readers to understand. The manuscript must be typed using double-spacing with a 4 cm margin on the left-hand side. The manuscript should be arranged under headings and subheadings. The word length for the type of article must not be exceeded. First and third person voice (I, we) is discouraged. Illustrations should be used to aid the clarity of the article; do not include several versions of similar illustrations, or closely-related diagrams, unless each is making a distinct point.

Authors who are unable to submit their articles in English should contact the editors so that any alternatives may be considered. We can offer some assistance to Francophone authors.

5. Manuscript Preparation and Layout[8]

Title page

The title page should contain the title, abstract and keywords – but NOT the author's name or affiliation.

In addition, there should be no mention of the name or address of the institution where the research was undertaken.

Abstract and key words

[8] These instructions will be followed when submitting the paper to the journal; for the purpose of the thesis I judged more appropriate to include colour figures in the text.

The abstract should be contained in both the manuscript submitted by the author, and in the appropriate box in the online submission webpage. The online version of the abstract must match the one on the manuscript. The abstract must not exceed 200 words and must summarise the paper, giving a clear indication of the conclusions it contains.

The author can select up to six relevant keywords during the online submission process. Keywords should be carefully chosen from the provided keyword list on the website, although it is possible to add other keywords. Keywords on the submitted manuscript must match those provided online.

Tables and Illustrations

Authors should aim to present table data as succinctly as possible; tables should not duplicate data that are available elsewhere in the article. Tables should be uploaded as separate files, and given the file designation ‘table’ during the file upload stage of the submission process. They should not be included in the main body of the text and should instead be referred to in the text as, e.g. 'Insert Table 1 here'. The actual tables and information should be included at the end of the paper, numbered in the order they will appear in the text as 'Table 1' Table 2' etc.

Illustrations must accompany the manuscript but should not be included in the text. Monochrome photographs, black-and-white figures, diagrams and charts should be referred to as 'Figure 1', 'Figure 2' etc. They may be uploaded as separate files and given the file designation ‘image’ in the file upload stage of the submission process. They should be numbered in the order in which they are referred to in the text, and presented one per page. No colour should be used.

Illustrations should be submitted in a form ready for reproduction – no redrawing or re-lettering will be carried out by the Publisher. A list of captions must

be provided for all figures. Images should be supplied digitally as high-resolution (300 dpi) tiff, jpeg or eps files. Figures need no border around the edge. Please avoid the use of 3D, shadow effects and backgrounds. Please also avoid computer screen-dumps as illustrative material. Note that figures and graphs must be comprehensible in black-and-white: line drawings and hatching should be used in lieu of grey scale or colour. If colour is essential, the additional cost for including colour will be borne by the author.

Symbols

Please use SI (Systeme Internationale) units. Whenever an acronym or abbreviation is used, ensure that it is spelled out in full the first time it appears, e.g. International Monetary Fund (IMF).

Acknowledgments

The author's Acknowledgments should NOT appear on the submitted manuscript.

The acknowledgments can be added upon acceptance and are limited to one paragraph.

Research funders increasingly expect to receive recognition of their support for research, and we encourage transparency in the publication process for research literature. Authors whose work has been funded are asked to provide an acknowledgment using a form of words similar to: "This work was supported by the - ---- (name of research council or other body) under grant number - - - - ."

References

References should be presented in 'author/date' style in the text and collected in alphabetical order at the end of the article. All references in the reference list should

appear in the text. Each reference must include full details of the work referred to, including paper or chapter titles and opening and closing page numbers.

Journals

Smith, D.W., Davis, L.M. and Price, B.N.,1993, An Analysis of the EU ETS. Climate Policy 4, 164–172.

Books

Price, B.N., 1993, An Analysis of the EU ETS. Earthscan, London.

Price, B.N., 1993, An Analysis of the EU ETS. In: Davis, L.M. (ed.) The EU ETS. Earthscan, London, 77–94.

Proceedings

Smith, D.W., Davis L.M. and Price, B.N., 1993, An Analysis of the EU ETS. In: J. Smith (ed), Proceedings of the 8th Annual Meeting of the Society for Carbon Management, Paris 1993, Earthscan, London, 150–164.

Endnotes

Endnotes should be kept to a minimum. Please indicate endnotes with a superscript number in the text, and include the note at the end of the article. Do not use the footnote/endnote commands in word processing software for either references or notes. Endnotes should not be used for academic or project citations.

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[9] Ibidem.

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ANNEX 2 - STOVETEC INSTRUCTION MANUAL

One-Door Stove Manual

This instruction manual can be translated into the local language. For a template, please contact:

StoveTec
PO Box 1175
79093 Highway 99
Cottage Grove, Oregon 97424
USA
541-767-0287
Instructions by Evan Shenkin and Nordica MacCarty

www.stovetec.net

Detailed Instructions for One-Door Wood Stove

- To light the stove, place some kindling inside the combustion chamber. Add larger pieces of wood when the flame is established. Continue pushing sticks into the stove as they are burned. Do not overfill the stove.
- Clean ashes from stove after each use.
- The adjustable pot skirt helps to save fuel! Loosen the nut and adjust the skirt so that it touches the top of the stove. Then tighten the nut.
- Always use the stick support so air can come up through the burning sticks.

➢ **Use the stove only in a well-ventilated area!**

➢ **Do not use the stove indoors.**

➢ **Keep the stove out of the rain. Keep it dry.**

ANNEX 3 - SUMMARY OF KEY FINDINGS ON WOOD EXTRACTION AND CONSUMPTION IN NHAMBITA, MUNHANGANHA AND BOE MARIA

Introduction

This section is a summary of key finding on wood extraction and wood consumption patterns in the villages of Nhambita, Munhanganha and Boe Maria, where my field research was completed in partial fulfillment of the requirements for the degree of Master of Sustainable Development and Management at the Stellenbosch University, from the 28th May to the 30th June 2009.

The methodological tools used during the field research are as follow:

- 40 semi-structured interviews (Barriball and While, 1994; Bryman, 2004) were held mainly with women, but often (for 17 households) in the presence of the husbands, in order to define the socio-economic profile of households (HH), kitchen regimes (the energy consumption patterns of households whilst cooking), wood collection regimes, interaction with natural resources, cultural and indigenous knowledge systems and perception of the carbon offset project;

- Two participatory rural appraisal sessions were held (Chambers, 1992; Asia Forest Network, 2002; Chambers, 1994; World Bank, undated). One was held with the women, in order to understand their overall livelihood strategies and challenges (DFID, 1998), and one with the men, focused mainly on the management of communal and individual resources, farming practices, livelihood strategies and perceptions of the carbon offset project;

- A total of six focus group discussions were then carried out around the introduction of stoves. The stoves were distributed to three cluster groups from three different villages (Nhambita, Boe Maria and Munhanganha). An introduction to the stoves was organised with each cluster, and five days later, a follow up on the social response to the stoves was organised in each cluster;

- Several interviews were held with selected stakeholders involved in project management.

- In the 40 households, I also physically weighed, with a spring balance, the amount of wood that each household consumed on a daily basis;
- This field research is completed by qualitative observations which attempt to enrich the narration based on quantitative findings.

1. Fuel Wood in the Nhambita community

In the Nhambita community, a distinction can be made between fire wood collected for domestic cooking and heating purposes and charcoal making.

The first is strictly a non commercial activity, with no household reporting that they sell firewood, whilst the latter is strictly a commercial activity (personal communications). In other words, the people who produce charcoal do not consume it and carry out this activity for income generating purposes (Herd, 2007). Charcoal consumption in Nhambita is not wide spread, with only three households reporting that they occasionally use charcoal. The families using charcoal visibly count among the most affluent in the village.

In Nhambita, there was only one noticeable commercial user of fire wood, which is the bakery located at the entrance of the village. Bread is cooked in a large clay stove.

1.1 Charcoal in the project boundary

In the case of charcoal making, wood originates from direct tree cutting. Charcoal making is not so much an energy generating activity but rather an income generating activity often fuelled by "failures in the agricultural system" (Leach and Mearns, 1988). Past research (Brouwer and Fãlçao, 2004; Herd, 2007) established that in fact the charcoal produced in the area was mainly directed towards the urban areas. Charcoal production is to be construed mainly as an income generating activity, which far more benefits transporters and wholesaler traders than the hard working producer (Brouwer and Fãlçao, 2004). Only two households in the sample respondents indicated they used charcoal as a secondary fuel. No evidence of charcoal production in the Nhambita area was found. This activity is forbidden in the buffer zone of the national park (Herd, 2007).

1.2 Type of biomass used for cooking fires

1.2.1 Wood

In terms of the nature of the biomass combusted, most and foremost, it stems from dead branches and twigs, which are either collected from the ground or broken off or chopped off with a machete from tree trunks, a finding which verifies accounts that dead wood "accounts for the bulk of rural firewood" (Leach and Mearns, 1988:1)

Surpluses arise from agricultural land clearance. The big logs found burning throughout the day in most households testify to this abundance.

Wood fuel in the study area is also the by-product wood from the trees harvested for the sawmill operations, the by-products of which are left behind. The sawmill,

however, records very high recovery rates, with implies that modest quantities of wood are left behind (Goss, 2009).

The wood used for cooking and heating purposes is almost exclusively dead wood. All respondents but two indicated collecting systematically and only dead wood for cooking purposes. Deadwood is generally reported as being (Clarke *et al*, 1996, cited in Shackleton, 1998) the most favoured and the most available fuel. In the case of Nhambita, dead wood is also the resource prescribed by the 'project' for these uses. The harvestable wood would, according to research done on this topic, in fact often constitute just a relatively small portion of the total standing biomass. Mudekwe (1997), cited in Shackleton (1998) found that 77 per cent of dead biomass could not be harvested manually because of its high location.

Fire wood is usually either collected on the ground or from branches cut from a height of up to 1.8 meters. These branches are sectioned off manually, or by throwing a piece of wood tied to a rope which would lodge in a branch and then be pulled down. The average diametre of the pieces of wood collected was 8-10cm which corroborates with Luoga, Witkowski and Balwill's (2002) finding that in general harvesters prefer wood with a diametre superior to 10cm.

In a few instances (this was encountered in two households), people would also use the wood of a structure they have dismantled for fire wood. The structure in question would be fences (fences to keep goats in are made of large trunks put in the ground at short intervals) or houses. It was found that the average life span of a house in Nhambita was six to seven years. The house would either be destroyed after a wall collapsed or the house in which someone died would have to be destroyed for cultural reasons. The wood is then used for fire wood.

1.2.2 Agricultural residues

Other biomass sources used that were often encountered included agricultural residues.

The most used agricultural residues, in order of importance (i.e. the frequency at which they were mentioned) were maize stalks (62.5 per cent of respondents) and sorghum stems. It was not possible (and not the purpose of the study) to quantify the amount of maize stalks used for cooking. This is obviously a highly seasonal phenomenon, with many stems being used after the harvest. In that time period, respondents indicated they could cook a whole meal, about two to three times a month, with the equivalent of a 10 litre bucket of stalks. This information could not be verified. During the rest of the year, maize stalks are used when they are available (as people tap into the stored maize), mainly to ignite the fire. The other types of biomass mentioned to ignite the fire were sorghum stems and dry grass.

In a few instances (7.5 per cent of respondents), respondents also indicated that they used the pruned branches of the pigeon pea trees they planted. The ratio of pigeon pea wood compared to other sources of wood for cooking could not be assessed. It was often used when women did not have the time to go and collect bigger branches. The villagers in Nhambita do not use dung at all for cooking purposes, as there are no large ruminants in the area.

1.3 Kitchen regimes

The findings on the kitchen regimes are summed up as follows:

- Seven HHs use fire wood commercially (to generate income), either in the form of beer brewing or cooked balls of crushed rice;

- HHs on average cooked 2.6 meals per day. The most important meal of the day is lunch time;

- All meals include a portion of maize porridge (maize porridge, called "tsima" in Sena) accompanied either by tinned fish, vegetables such as African beans and pigeon pea;

- 10 per cent of HH cooked on a free stove fire – four respondents also had a charcoal stove which was used only occasionally – mostly in adverse weather conditions;

- 50 per cent had a fire place inside their main house or kitchen – in which case the cooking is mostly done inside when it rains;

- when asked, HHs indicated in 95 per cent of cases that they cooked mostly outside – only two HHs indicated that they cooked all meals inside in all seasons;

- 58 per cent of HHs indicated leaving their fire burning throughout the day – a correlation was noted between HH affluence and day long combustion of woods – the logs brought in by the men are usually left to slowly simmer throughout the day. Other HH where labour is less readily available (in the case of newly established couples with no or just one child, monogamous couples, frail elderly HH) and timeless available because all subsistence comes from the food grown with no external injection of

money, would systematically put out their fire after cooking the meal and then go to their neighbour to get coals to light the fire again;

- 20 per cent of HHs had two fires burning at the same time at a given time of the day. This was the case where several HH shared a communal area. In this set up, the man usually has two or more wives (during the field research, it was found that men could have up to four wives) who each have their house, but who share the courtyard where all the crushing, meal preparation, cooking and socialising takes place. Once they have children, the sons who come of age often build a house close to the parental house (or in a different location) where his wife will come and live. The extended family therefore lives in the same perimeter but there is a clear gender barrier that then has to be respected. Since men cannot culturally be associated with the cooking duties, they are "not authorised to go near the fire where the pots are cooking" (interviewee) – the men therefore, especially in the cold season, make their own fire to sit around, mostly in the evening. Mostly, the women do not sit around that fire, although the field research found that all HHs did not strictly respect that second convention. "Dual fire" situations therefore applied in a context where many people gathered on the premises. This situation did not occur in contexts where the children were still young and living with their parents, but it did happen in monogamous set ups, where the children have taken a wife and live in the communal set up described above, with their parents.

- 48 per cent of HHs indicated that they used fires for space warming; but this was not deemed to be a relevant statistic because the interviewees

never spontaneously specified this and only did so when prompted. One could argue that all HHs, especially in the cold dry season, do use the fire for space heating. However, since most fires are lit outdoors, the notion of space heating becomes inappropriate.

1.4 Wood collection regime

All research undertaken on fuel wood reveals the preeminent role of women in this respect. Especially in Africa, women almost systematically carry the exclusive burden of collecting wood for cooking (Hassen, 2006). This is also the case in Nhambita, where women almost exclusively are responsible for wood provision with the help of their children. An average of 2.2 people per HH are in charge of wood collection, which refers to women and children. But 37.5 per cent of households reported that men played a part in it. The average number of trips per week that women made to collect wood was 2.3.

On average, men collect large dead logs and would do so about once a week. This was a notable aspect of the division of labour in the research area, with women carrying exclusively head bundles and men, if ever they collected wood, carrying exclusively logs. This wood was either used for cooking, especially in HHs were the second fire is not used, and mainly used for the second “men” fire when two fires are lit. One female respondent indicated “the men go and fetch their own wood”.

Women collect an average of 2.6 bundles of wood per week. The size and weight of bundles varies significantly, from six to 28 kg. 50 per cent of HHs used a tool (knife or/and machete) to collect wood.

1.5 Wood collection area

Wood fuel supply in the Nhambita partly originates from the residues of pressures put on forest land by agricultural “slash and burn” activities. Wood is i) collected from pollarded trees in agricultural lands or on the bordure of *Machambas* and from ii) scattered woodland sites. Women generally do not venture deep into the woods, some of them reporting their fear of encountering animals and mostly the dense forests are respected and feared for spiritual reasons, so women usually collect dead wood on the border of woodlands.

Wood acquisition time is obviously correlated to the distance to the resource. In Nhambita villagers are very close to the resource base, where a short trip suffices to collect a big bundle of wood. In general, dead wood would be collected relatively close to the settlement, as it was found by several studies that availability of fire wood increases with distance form settlements (Loga, 2002; Shackleton, Grundy and Williams, 2004).

Time estimation by respondents was one of the biggest methodological difficulties since women often did not have a notion of time and relied on vague time estimation based on sun revolution. Some respondents indicated that it took them one to two hours to get to the wood collection point. Estimations of distance walked by humans over an hour are estimated at 5km (Hassen, 2006). This was confirmed by empirical evidence gathered on the ground, by following the women collecting wood. An average distance of 2.5km distance traveled for a half an hour trip.

After having walked the distance traveled with three respondents, it was clearly established that the total journey averaged one hour, inclusive of fuel collection time.

This contrasts with countries or regions where wood scarcity, for climate, environmental degradation or political reasons, is very far from the resource base. In Ethiopia for instance, research done in the 1991 opened Kebribeyah refugee camp which in 2006 sheltered 16,000 Sudanese refugees, average time per trip was 2.6 hours (with many women traveling xxx hours) with an average distance walked of 8 km (n=10 households) and (Hassen, 2006). As a result, 85 over cent of women in Ethiopia reported that wood gathering took the better part of their time whilst in Nhambita wood collection is the least time consuming activity (as testified by the time allocation exercises see annexure).

46 per cent of people indicated that they would collect wood from the *Machamba* as well as the forest – this again is not a reliable statistics because it was understood through the discussion that wood collection regimes was a cyclical pattern, whereby after a new *Machamba* had been opened, there would be a large supply a fire wood available to collect for a long time. Once this reserve was out, then the HH would resort systematically to collecting wood in the forest. For HH who had a contract and who were constrained not to extend their fields in the past years, they only collected their fire wood from the forests.

1.6 Wood storage

When asked whether they stored wood in the wet season, 60% respondents indicated that they did. The period duration of storage often equated to the number of days weekly wood stocks actually lasted. One week storage can be considered as minimal storage and only 6 HH reported storing fire wood for more than a week, in the wet season. Wood is in most cases stored underneath the main house or kitchen porch, or

sometimes just underneath the thick canopy of nearby mango trees, where pieces are stacked vertically to avoid the rain water from penetrating into the wood.

1.7 Demand for fuel wood in the project area

Level of demand of fuel wood is determined by "household size, household wealth and the availability of wood" (Borsboom, Hektor, McCallum and Remedio, 2002:272).

The rule according to which as household size increases, wood consumption per capita decreases (Benbridge, 1995, cited in Borsboom *et al*, 2002) was taking into account when calculating patterns of wood consumption. A distinction was therefore drawn between per capita usage and per household usage, since in general there are more people eating a meal from a fire cooked than the household actually counts family members.

The limitations of the findings of in terms of quantitative use of fire wood are underlined and discussed in the methodological section (variances in terms of seasonality, "unusual days", etc could not be determined within a month).

I made use of a spring balance to measure the wood usage per day per household (HH)) in 40 HH. The number of individuals per HH was also taken into account to estimate a per capita usage.

It was found that households in the project area consumed an average of 16.67 kg of wood with a standard deviation of 10.53. Considering that the average number of people per household in the sample (n=40) is 5.36, this translates in an average of 4.74 Kg of wood consumed per HH per day with SD of 7.57. But as indicated above, there are generally more people (5.97) eating meals cooked from the HH fire than

people in the HH (5.36), which results in an average of 4.6 kg of wood per person consumed, with a SD of 7.77. Overall fire wood consumption in the project area can therefore be estimated at 1.62 m³ per capita per annum. (See detail below). These figures are to be considered in light of the limitations enunciated above.

wood consumption per HH		
daily average	17.32	
daily average	16.87	
std dev	10.53	
monthly average.kg	519.55	
yearly average.kg	6321.22	
yearly std dev	3841.64	stdev(cX)=|c|*stdev(X)
Wood consumption per person		
Assuming specific weight of 650 kg per m3 and 5.36 people per HH		
	9.72496	cubic meter per HH per annum
	1.814705	m3 per person per annum
daily average	4.73	
std dev	7.57	
yearly average	1726.78	
yearly std dev	2764.07	
wood consumption per person eating (over and above number of people per HH)		
Assuming specific weight of 650 kg per m3 and 5.97 people per fire eating		
	1.627783	m3 per person per annum
daily average	4.60	
std dev	7.77	
yearly average	1680.80	
yearly std dev	2837.71	

Table 1: Calculation of wood consumption per household and per capita in the research area

Source: Compiled by the author

This consumption pattern falls within the consumption bracket defined by O'Keefe (1984) for African savannahs, which was estimated to range from 1.1 to 1.7 m³ per annum (p.a.) per capita (p.c). This consumption is superior to what was found for urban contexts in the Southern African region, which spans from 0.83 m³ p.c. p.a. in African cities (SADC, 1998. cited in Brouwer, 2004) to 0.92 - 1 m³ p.c. p.y in Maputo Williams (1993), as cited in Brouwer and Fãlçao (2004). Higher fuel wood consumption in rural areas close to an abundant resource makes sense, especially in view of the consumption and kitchen regimes described above. This consumption

level is higher than the average for the Democratic Republic of Congo with 0.91 m³ p.a. p.c. (Agarwal, 1986, as cited in Brouwer and Fãlçao, 2004).

Geographic area	**Biomass**	**Date of research**	**Quantities per capita (m³ equivalent)**	**Quantities per HH**	**Source**
African cities	Fuel wood	1998	0.82 m³ p.a.		SADC (1998) in Brouwer (2004)
Rural areas in Africa in general	Fuel wood	1992	0.9 m³ p.a.		Bila (1992) in Brouwer and Fãlçao (2004)
Maputo	Fuel wood	1993	1.16 kg p.d. From 0.92 to 1 m³ p.y	5.8 kg p.d.	Williams (1993) in Brouwer (2004)
Maputo	Charcoal (conversion rate 7.14 kg biomass for 1 kg of charcoal)	1993	0.16 kg p.d. 0.82 m³ p.y		Williams (1993) in Brouwer and Fãlçao (2004)
Mozambique	Charcoal	1997		5.18kg but large variation (7.92 ±2.36kg) p.d	Ellegard.1997 in Brouwerand Fãlçao (2004)
Maputo					Brouwer and Fãlçao (2004)
Uganda	Fuel wood		1.77 m³ p.a.		Agarwal (1986) in Brouwerand Fãlçao (2004)
DRC	Fuel wood		0.91 m³ p.a.		Agarwal (1986) in Brouwer and Fãlçao (2004)
Ethiopia	Fuel wood			3689.4 kg p/a[10]	
Malawi (National Park)	Fuel wood		9.9 kg per week		Abbot in Miombo in transition
Savannahs	Fuel wood		1.1 to 1.7 m3 per year per person.		O'Keefe (1984)
SA average	Fuel wood			3,200 to 3,600 kg pa = average 45kg per	Lawes *et al* (2004)

[10] 2012.4kg for cooking and 1677kg for baking p.a.

				month	
SA rural communities	Fuel wood			4,5 t p/a	Lawes *et al* (2004)
South Africa average	Fuel wood		between 0.27 and 1.12 tonnes per capita per annum		Lawes *et al* (2004)
coastal areas of the Eastern Cape	Fuel wood			3.9t /pa	Lawes *et al* (2004)
Umzimbuvu district	Fuel wood				Lawes *et al* (2004)
South Africa rural average	Fuel wood			Total 13 million m3 pa total	Shackleton (2004)
South Africa rural average	Fuel wood			5.3 tones p.a.	SA 2030 forestry road map
Zaire Miombo	Dead wood			874kg/ha to 4.4 t/ha	Malaisse *et al* (1972) cited in Shackleton (1998)
Nigeria				682 kg pc pa	Ollines (1977) cited in Shackleton (1998)

Table 2: Comparative analysis of wood consumption in different African biomes

Source: Compiled by the author

1.8 Tree species used for fire wood

In this section, only the indigenous names of the species could be collected. Many sources offer indexes to match indigenous names with the scientific names of species, but this was not the purposes of the research. I apologize for any misspelling of indigenous names and hope the project team will be able to make use of this information if needed.

The species that were the most frequently mentioned as favourite species for cooking fires were: *MUSASA, NTURONGO, MFITI, MUVIMBE.*

The trees which are “not allowed to be extracted” but that in fact people do not cut because of traditional beliefs, are:

UMKANANE It is commonly believed that if this try lies in the yard, then it

	will create conflict between the husband and the wife. There was wide consensus that this wood should never be used for making fires.
MUKUNANI	Same reason as above
MMUVUMOROPA	Which is reported to give off too much smoke and cause chest problems
MUKUNANBIRA	Reason unknown

Some species of trees cannot be cut because these trees require permit to be sold as timber but out of forty respondents, only one (well informed) person[11] made that point. These trees species are: *PANGAPANGA, MBIRA, SOKOSA.*

2. Construction wood in the Nhambita community

For this section, the sample size was 12 households. I attempted to measure the total wood content in all households was measured in order to deduct the total amount of biomass stored in houses. I did not complete this part of the research because of methodologies uncertainties. Interesting observations cold however be made.

2.1 Houses in the project area

The structures found in the yards of people consist mainly of: a main house (for all households), a maize or/and sorghum storage structure on stilts (for most houses), an outdoor kitchen structure (consisting of a red roof perched on poles), a built kitchen in which in some of cases people also slept, a stilt structure (referred to as "*chitata*" in Sena), on which people place pots and pans away from the ground dirt and animals and in most cases, an outdoor bathroom built of bamboo and grasses.

The maize storage in the house or/and kitchen is built inside the house and usually rests on four strong (average diameter xx) strong wood. The maize is either stored on

[11] The respondent was a professional crafts man so the nature of his professional activity implied a good knowledge of rules and regulations

the layers of wood only or it can be enclosed in a circular shaped basket reed weeded to the wooden structure.

Houses are built out of wooden poles and bamboo (mainly for the roof) which constitute the frame of the house which is then rammed with earth. Roofs are made out of packed reeds. Very few houses have corrugated iron sheets for roofing.

The life span of houses built hovers between four and seven years. This finding may be biased by the fact that many respondents had only recently settled in Nhambita or built a house so the structure's weather resilience had not been tested. The part of the house which gives in first is usually the roof, followed by the walls, which crumbled because the untreated wood rots.

House building is exclusively the domain of men. Women therefore did not know much about the nature and location of the wood extracted. In 58 % of cases, the building of the house was outsourced to a builder for a price averaging 400 Mts.

All poles used for construction come from live trees, and in most cases trunks of the required size were cut for building purposes. Most people said they got these poles from the forest in areas where it is allowed to extract NTFP. This information was however invalidated by the participatory rural appraisal session with the men, who indicated that the best, straight and rectilinear poles could be found in the dense "*Guacha*" forest which is normally forbidden to access. This is seconded by Luoga (2002), who found that poles were comparatively more frequently extracted from the protected area in Tanzania than in communal land. This confirms the fact that rural dwellers prefer to extract construction poles from denser canopy forests.

2.2 Trees species used for construction

The part of the tree used for construction is in most instances trunk wood for the walls of the house and thin tree branches for the roofing. All houses comprise of wood poles extracted from adjacent forests and bamboo, generally bought from the neighboring village of Mathanda, close to the N1. The prices cited was 10 Mts for 10 bamboo poles.

The species (for trunk) that were the most frequently mentioned for house building purpose were as follow:

MUSASA	*MULIWI*
TANGA TANGA	*MFITI*
KAGORO	*MUYUGUFI*
HIMBE	*CHIGURA MADMO*
NYAKABALE	*MUJOTOTO*
CHACHANY	*PAKASA*

For smaller twigs:

MUTARARA
MULIWI
MUNYONGALO

The trees which are “not allowed to be extracted” (which in fact means that people do not cut because of traditional beliefs), are:

UMKANANE because the presence of this wood creates marital conflict (see section)

All the species listed below were mentioned because of their slow decay properties:

NKUNITI
MPINGUE
NANGARE
NGUNKU

3.1 Management of resources: rules and customary principles

3.1.1 Regulation

Extraction of natural resources within the community land is subject to Government approved management plans and is to be managed, as per the 1997 Land Act, for the benefit of the entire community (Spadavecchia *et al*, 2004). The enforcement of extraction rule is carried out by three conservation officers on bike who work under the umbrella of a twelve member committee responsible for natural resources and which falls under the joint management of the Gorongoza national Park (which contributes 20 per cent of its running costs) and the Nhambita community association (Jacobe, 2009).

Their tasks are to monitor fires, control the illegal activities of animal poachers who set up traps or poison the rivers to catch fish, to control the cutting of trees and bamboo without a license and to monitor "how people cut trees" (Jacobe, 2009). They work in conjunction with two forest technicians who are Envirotrade permanent staff members.

The latter's role is to educate villagers on agro-forestry principles, to monitor the death rates of the trees planted under the *Plan Vivo* standard and also to monitor the illegal opening of new *Machambas* and to monitor the cutting of trees for building purposes. (Ranguisse, 2009). They act as the intermediaries between Envirotrade and the villages.

3.2 Respect of regulations?

All respondents indicated that there is no restriction in the number of trees one can cut for construction purposes, as long as it is for a legitimate (domestic) purpose, such as

building a house. The basic rule for extraction was described as follows: people would select strong and big trees for poles and let the smaller ones to grow

A wood carver indicated that the implicit rules to follow are that if they are two trees of a same kind in an area, one should only cut one and at a height of 30 cm above the surface to allow for coppicing. Carpenters and artisans would have this knowledge but it could not be asserted whether other villagers had this knowledge. The perception is that all woods would shoot up again if they are cut properly. The coppicing potential of Miombo wood species had effectively been widely documented (Chiyumado, 1988, Shackleton, 2001).

Management methods (coppicing) depend on the intended use of the resource and the current levels of standing biomass, as different management practice lead to more or less faster replacement. Shackleton (2001) found that single pruning treatment resulted in stems on average 54 per cent longer with a shortest return time (which is good for poles), whereas the non pruning treatment resulted in the greatest cumulative length and therefore mass of coppice, i.e although stems were thinner, the no prune treatment led to greater productivity. The higher the tree is coppiced, the more chance of survival and the more coppices shoot

4.1 Observations on uses and customs with regards to wood usage and fires

4.1.1 The sociological function of fire

The way fire is used is intrinsically related with the way a household is defined. If a man has two wives, they act most the time as entirely independent and autonomous units.

> (it is important that) each wife manages her own resources and that she can cooks when she wants for her children (Bernardo, 2009).

The remarkable feature is although fire wood collection represents a physical effort, each wife makes her own fire. The man's fire is not use for cooking whatsoever it is a social place of encounter for men. Certain wives indicated that they would never borrow wood from the other wife, whilst other wives were seen cooking together and sharing the wood collected.

4.2 Customary beliefs on wood and forest

Interaction with natural resources based on traditional beliefs – *UMKANANE* for instance cannot be introduced close to the domestic space else it will created marital conflict. It can be assume that such traditional beliefs were "instituted" to protect some resources.

People believe they are not allowed to step in the "dense forest" (referred to as "*guacha*") because that it is where people are buried and there is a firm belief that one should not disturb the peace of the dead for fear of adverse repercussions.

4.3 Perception of deforestation in the project area

If 66 per cent of respondents indicated that they were less trees that they used to be five or ten years ago and 75 per cent of respondents indicated that they were now working a longer distance than ten year ago to find wood, the entirety of the respondents nonetheless indicated that to them this was not a problem, that dead wood would permanently be available

These perceptions in terms of biomass availability are a clear indication of a pressure on local systems. But we also need to take into account the fact that since most the wood that was collected in the *Machambas* has been used and people are starting to

stop extending their fields, the impact of fuel wood availability will be immediate. More people now go to the forest to collect wood, as opposed to going to the *Machamba* to get wood but in a business as usual scenario, they would have reported that they only need to walk to their fields to collect wood because they would still be able to extend their fields

Asked about what were the drivers of deforestation according to them, some people answered that poverty is the main reason, because “if we had concrete we wouldn’t build wooden houses”.

4.4 Health considerations

In interviews, there was little recognition that breathing smoke could be harmful to health. When interrogated about the inconvenience of smoke, no household indicated it was an issue, with some underlining the important function that smoke played in repelling insects attacking crops. A fuel stove projects in xx was reported to have failed when the project hosts realized that the decreased smoke stemming from the stoves annihilated the effects of insect repellence. However if smoke does contribute to keeping smoke away, portions of harvested crops are still lost to insects.

Conclusion

The introduction of wood stoves could be construed as a preventative measure to slow down this reaching of the frontier and consolidate the preservation of forest acquire thanks to *Pan vivo*. However, many cultural parameters need to be taken into account for a market driven dissemination of stoves in Nhambita. Methodological aspects exclude the possibility to push for this project from a carbon offset perspective. The Bottom of the Pyramid (BOP) approach would therefore be a more suitable approach,

bearing in mind that the project is already endowed with many attributes required to tap into BOP markets, such as trans-national distribution channels (in partnership with a local entrepreneur in Chimoio), local distribution networks and technical support (forest technicians).

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ANNEX 4: Interview Templates Used In the field research

(in English and Sena/Portuguese)

4.1 Defining the energy baseline and kitchen regimes in Nhambita/Chicale Regulado (n=40)

SEMI- STRUCTURED INTERVIEWS[12]

Interviews to be made with each of the 20 test household + 20 control households

Weighting tests to be carried out over 3 days, avoiding Sundays and festivities[13] - interviewees will be asked to show me the amount of wood they typically use in a day – if they do not have enough stock for that I would make an arrangement to come back on a day when they can show me the amount set aside for cooking for the day

1. Ice breaker – mapping exercise

[12] As much as possible, all the questions in the interview templates were asked. Depending on the interviewee's responsiveness and ability to respond, some questions could be omitted or elaborated upon.

[13] The proportion of abnormal days needs to be assessed (Shackleton)

Make a drawing of the family members and where they live – how space is shared						
From this drawing, show functional places – sleeping, cooking, washing, water source, playing, working (the drawing can extend in the space of the village)						
How much time do you spend doing these different tasks? (respondent to allocate number of beans per task on drawing)	Child care	Cooking	Wood harvesting	washing	farming	other

2. Interview

Date of interview_____ Location of house (GPS) _____

Name of interviewee_____

Date of interview_____ Location of house (GPS) _____

Name of interviewee_____

N°	Question	Answer					
Socio economic assessment (defining clusters)							
1	Muri vangasi pamuhi Family size	0-5	6-10	10+			
2	Muna vana vangasi vari pasi pegumi ramakore? How many children under the age of 10 are they in your HH?						
3	Mbani ambanhanha kupika pamusha panu? Who cooks most the meals in your home?	Munhu mubodzi-bodzi? Is it always the same person?	Mukadzi munango anapikirambo munango mukadzi njache? Does one wife cook for the other wife sometimes?				
4	Una pika para familia basi kana kuti unapikira vanambovo? Do you only cook for your family or do you sometimes cook for others?	Tsizvo/kabe.Yes/no	Unapikanji? What do you cook?	Kakawanda tami? How often?			
5	Muna shandisa nkuni para kubika zvakugurisa? Do you use fire wood for commercial uses?	Baking/cooked meals	Kugadzira matijoro.Brick making	Kubika doro/zvinango Beer making /other			
6	Munagurisa nguni dzanu muna tora mutsanga? Do you sell wood that you collect?	Kangasi/zidawanda tani How often & quantity	Mudagurisa conta janji? Selling price	Anagura? Who do you sell to? Where? Ana muna girisa kuponi?			
7	Pane anagurisa marasha pamuhi? Does anyone in your home produce charcoal?						
Fuel mix							
8	Munashandisanji pakupika nguva zidavanda? What (fuels) do you use to prepare food with most the time?	Gas	Magetsi Electricity	ncuni Wood	Ndove-Dung	marashaCharcoal	Mararaamumunda(tipo)Agriculture-waste (type)
9	Tangue ranji?Why?						
10	Tsvayi zvinango zvanu munashandisa kupikisa nguva dzinambovo(muchaka) Which ones of these other fuels do you sometimes use and at which frequency	Gas (LPG)	Magetsi-Electricity	Ncuni-Wood	ndoveDung	Marasha-Charcoal	Mararaamumunda(tipo)(Agriculture-waste (type)
Current kitchen regime							
11	Muna pika kangasi padzuva ribodzi? How many meals do you cook a day?						
12	Muna basa moto kangasi padzuva? (moto udawanda tani) How many fires a day?						
13	Muda basa rini moto? When did you start this fire?						
14	Muna siku zinango zanu muna shandisa moto vakuwanda kupinda zinango? Kana kwaitikanji? Are they days when you cook more or less fires than on a normal day? Which days?						
15	Muna siku zinango zanu muna siya moto nguva idareba? Kana kwaitikanji? Are they days when you make a fire longer than on other days? Which days?						
16	Munapika comida para kuzodya yatonhora? kana ndizvo itipo iponi yecomida? Do you cook food to eat cold later? If so what type of food and how						

	often do you do that?						
17	Comida ipi yanu munanhanha kugadzira? What do you normally cook or prepare for each meal?	Matabicho/ Breakfast		Almoco/ Lunch		Jantar /Dinner	
18	Hora zanji? (where is the sun?) At what time?						
19	Moto unabaka hora zingasi? For how long does the fire keep going?	Matabicho Breakfast		Almoco Lunch		Jantar Dinner	
20	Comida yanu muna pika idawanda tani?(peso) Quantity of food per meal	Matabicho Breakfast		Almoco Lunch		Jantar Dinner	
21	Munapikira paponi comida? Where do you prepare your food?	Munhumba Inside	Pabanze Outside	Dependem/ronga razao	Depends/ explain factors		
22	If inside: how big is the space?	10 m3	20m3	20+			
23	Comida yanu muna igadzira paponi? On what do you prepare food ?	Mbuto idafungu ka Open fireplace	Fugao Stove(typo) mangasi and how many Photo	Zvinango Other			
24	Kana muri munhumba muda kura tani? If inside: how big is the space?	10 m3		20m3		20+	
25	Munaviridza (vhaidza) madzi? nguva yakareba tani? Do you boil water and if so for how long everyday?	0 – 30 minute minutes	31 – 60 munute minutes	1-2 hora hours	2-3 hora hours	3-4 hora hours	4-5 hora hours
26	Munapika nguva idareba pakumara kwasimana/domingo?nguva ikareba tani? Do you generally cook longer on a week end/Sunday and if so how long?	0 – 30 munite minutes	31 – 60 minute minutes	1-2 hora hours	2-3 hora hours	3-4 hora hours	4-5 hora hours
27	Ipwando riponi ranu munopika comida yakuwa? What are the celebrations for which you cook bigger meals than usual?	Tipo yafesta Type of celebration		Nguva iponi yechaka Time of the year		Tipo yacomida netembo Food cooked & for how long	
28	Muna uraya mhuka yakakura kwapera tembo yakareba tani?iri muka ya ipi? How often do you kill a big animal for a big celebration and what kind of animal?	Tipo yamhuka Type of animal		Chinangwa Occasion		Inagara nguva ida reba tani pamoto? Time cooking	
29	zvinango zvanu munoshandisa moto? What else do you use your fire for?	Kudziisa heating		Kuvhenekera lighting		Zvinango Other (rituals?)	
30	Tempo idarebatami? For how long?						
31	Muna tempo dzanu muna koya paneira ina comida yapisa munachira para kuti irambe itchiziya? Do you sometimes cook in a pot and leave the pot in a hot blanket to finish the cooking?	Ndizvo/kabe	Yes/no	Tembo idareba tani?How often?		Riini? When?	
Economics of cooking regime							
32	Munadusa dinhero para kugura nkuni? Do you buy fuel to make fire?	Yes/No	Conta yanji? How much?	Conta pamolho Mts	Muna gura kuponi? where from?		
33	Munapagarwi parakubikira vanango?(zvisiri zvakugurisa)Do you get paid for cooking for others (apart from commercial)?	Ndizvo/ kabe Yes/No	Mts	Kuna ani?For whom?	Munagurisira kuponi? Where are your clients?		
34	Do you sometimes buy wood?	Yes/No	Mts per bundle/kg	From whom?	Where does the wood come from?		
Quantifying wood usage							
35	Munashandisa huni kangasi? (pasimana/mes) How often do you use wood?	Siku dzoseni every	3-4X/ week	1-2X/ week	1-2/ month	Haushandisi Never	Dependem Depends

	(Per week/month)	day					(elaborate)
36	Munashandisa nkuni zidawanda tani padzuva? How much wood do you use in a day? (respondent's assumption)	1-2 kg	3-4 kg	5-6 kg	7-8 kg	9-10 kg	10+ (write in)
37	Muna shandisa mamonho mangasi pasimana?How many bundles do you use per week? (Weigh Head bundle)						
38	Munashandisa nkunidzidawanda tani para kupika almoco? How much wood do you use to cook your lunch (same food)? (respondent's assumption)	1-2 kg	3-4 kg	5-6 kg	7-8 kg	9-10 kg	10+ (write in)
	Effective Weight						
39	Munashandisa nkuni dzidawnda tani para kuwirisa madzi?How much wood do you use to boil water (2l)? (respondent's assumption)						
Wood collection regime							
40	Mbani anatsvaga nkuni?Who collects wood?	Zita Name	Makore Age	Mwamuna/mukadzi Male/ Female		Vamufalia Family member	
41	Munambo shandisa transporte para nkuni? Do you ever use transport collect fuel wood?	Tipo type		Munashandisa pasiku zingasi? Frequency of usage		Razao Reason	
42	Munatora nkuni zidawanda tani panguva ibodzi? How much wood do you collect at a time?	1-5 kg	6-10 kg	11-15 kg	16-20 kg	20+	Don't know
43	Weigh						
44	Munatora mamonho makuru mangasi pasimana? How many head bundles do you collect a week?	Mamonho&huni zingasi? Number of bundles & number of sticks per bundle					
45	Munotsvaka huni kangasi? How often do you collect wood?	Siku zoseni Every day	Pamara mazuva maviri Every 2nd day	Kairi pasimana Twice a week	Kamwe pasimana Once a week	Kamwe pamasimana mawiri Once every 2 weeks	Kamwe pamwedzi Once a month
46	muda gumisira riinikutsvaka nkuni When was the last time you collected wood?	Zuro Yesterday	Zona 2 days ago	Pamala tsiku dzitatu3 days ago	Simana idamara Last week	Simana mbiri dzidamara 2 weeks ago	Zvinango Other
47	Nkuni zanu murikushandisa zida kura tani ? How big are the pieces of wood you normally use?	Measure – length - diameter					
48	Munashandisanji kutema nkuni?What do you use to cut the wood down with?	Saw	temo Axe	Zvinango Other			
49	Tipo dzehuni(zidanhanha) Type of wood collected (quantify %)	Miti idaoma Dead wood	Miti inorara/minhoro Live/green wood	Tsotso / Twigs: Branches: Trunks: Coppiced: Other			
50	Munafarira tipo iponi yankuni (What species do you prefer collecting (order of preference) + reason: less smoke, slow combustion?						

51	Munacoha nkuni? Do you store wood?	Ndizvo/ kabe Yes/no	Tembo idareba tani For how long?	Kuponi? Where?		Tangue ranji? Tempo iponi yachaka? In which season?	
52	Muna omesa nkuni hamusati mashandisa? Do you dry your wood before using it?	Ndizvo/ kabe Yes/no	Kuponi? Where?	tembo idareba tani? For how long?			
Reachable wood collection area							
53	Munatsvaga kuponi nkuni (pakareba tani) Where do you collect wood from? (how far, how and where)	0 – 500m		500 – 1000m		1000m +	
54	Muna tora nkuni kuma? Do you collect mostly wood from?	Machambas (kunangombo)(your or others)		Tsanga repaduze Close forest		Nzanga rekutare Far forest	
55	Munatora tembo idareba tani para huni? How long does it take to collect wood/trip?	0 – 30 min	31 -60 min	1-2 hours	2-4 hours	4-6 hours	6+ hours
56	Tichitarisa zvaca zvapinda miti iri kuwanda kana cabe Would you say that there are as many trees here now as a few years back?	Ndizo/kabe Yes/no		Please explain			
57	Mengati nzendo yanu muna famba ida chinja kana kabe? Would you say the distance you walk has changed with time?	Ndizo/kabe Yes/no		Muda tanga rini? When did you start walking more to fetch wood?			
58	Muri kushandisa huni dzibodzi dzene kana kuti dzidawanda kana dzishoma Muzvacha zviviri zvapinda? Would you say you use more/less/same amount of wood as 2 years ago?	dzidawanda /dzishoma		Please explain			
Forest management and regulations							
59	Pana munango munarambidzwa kutora nkuni kana kabe? Are they areas where you are not allowed to collect? Mbani asarambidza? Who tells you? Iri Kuponi mbuto yeneyo? Where? Tangue ranji? Why?						
60	Pana dzimango tipo zina rami dzana kutpra? Are they species you are not allowed to collect?						
61	Dziponi? Which ones? Tangue ranji? Why?						
62	Do you grow your own wood for fuel? Muna checa miti yani para kuzoita nkuni?			Tipo dzipi ? What species? Muda checa zimgasi? How many trees were planted?			
63	Muna pisa machamba/ kama ndzanga? Do you burn vegetation around you (machamba/forest)?	Rini? when?		Tangue ranji? Why?			
Seasonal variation							
64	Mwezi dziponi dzanu munatora mudzizi idarega yekushuda? Which months do you spend the most time farming?						
65	Mwezi dziponi dzanu munatora nkuni zakwanda? Which months do you collect the most wood?						
66	Ndikuni zakuwanda tami zanu zisasoendsesa imwe pamuzizi vakunaya? How much more wood do you consume in winter compared to summer?						
Health considerations							
67	Munhumba muna mukana mwahu wakupitisa nakubudisa mpepo? Do you have ventilation in your house?	Yes		No		Explain	
68	Nhumba yamu isakala nausi vakuwanda mungakala kuti muli kupika Does the house get smoky?	Yes		No		Don't know	
69	Usi uyu kupesa zvinango kana kuti kabe? Does the smoke serve						

	a purpose?			
70	Mukati mafamila yanu, aripo arikuneseka tangue yama fero? Does anyone in the family have respiratory illnesses? (i.e. coughing etc)	Yes	No	Details
Beliefs, use & customs around wood				
71	Are there trees which have special powers?	Which tree?	Why?	
72	Muna shandisa miti ida wanda tami para izv pachakai? How much wood (in the year) do you collect for: Quantity?	Kuwanka nhumba	kuveza	mitombwe
73	Miti iponi muna chandisa para zvenezvo? Which tree species do you use for that?			

4.2 The socioeconomic background of survey households in Nhambita/Chicale Regulado (n=20)
SEMI- STRUCTURED INTERVIEWS (English version)
Date of interview_____HH number_____
Name of interviewee/head of household_____
Gender_____Age_____Phone number_____

N°	Question	Answer		
Socio economic assessment (defining clusters)				
74	Were you born in Nhambita?	Yes/no	If not, where do you come from?	When did you settle in Nhambita? Why?
75	Were your parents born in Nhambita?	Yes/no	If not, where do they come from?	When did they settle in Nhambita? Why?
76	How many wives in the family?		When did you marry them?	How many children do you have from each?
77	Did anyone die in the family in the last 5 years?	Yes/no	Family member	Cause of death
78	How many structures are there on your plot? (list function: house/storage) sketch			
79	How many durable goods of value do you have? List them (watch, bicycle, work/farming tools, carpentry tools, fishing rod, paraffin lamp, pots, etc)			
Machambas				
80	How many Machambas do you have?	Machamba 1.	Machamba 2.	Machamba 3.
81	Date of acquisition			
82	Who farms it			
83	What is grown on it			
84	Total harvest last year			
Inputs				
85	Did you buy seeds? Cost for each machamba			
86	Did you install irrigation? Cost			
87	Do you use fertilizers? (if yes organic or chemical)			
88	Do you use pesticides? (if yes organic or chemical)			
89	Did you pay someone to farm it/how many and what are they paid per month?			
90	Total money invested in machamba for a year			
Burning regime				
91	Do you burn the machamba after harvest?	whole or portion of the machamba	Time of year/frequency	
92	Who does the burning?			

93	What happens to the trees on the machamba when you burn the machamba?						
94	How do you control the fire from spreading out?						
95	Have you abandoned a machamba in the past? Why?						
96	Do you still go on your old machamba?						
Income from farming							
97	Did you sell any of your harvest last year (legumes & fruit)? Product sold	Mts value per unit	Where ? market/village/other	To whom	Income generated		
Non timber forest products harvested							
98	What products do you harvest in the wild/forest? (by order of importance)[14]						
99	In which quantity?						
100	Do you sell them is so where and how many Mts/unit?						
101	How much money did you make from these products last year?						
102	How else do you make money?	Casual labour	Regular job	Selling of cooking	Selling of made products (which ones)	Charcoal making	other
103	Amount made last year						
104	Did you buy food last year?	Where?		Which produce?		How much?	
105	Have you taken loans?	How much From		where		At what interest rate	
Carbon income							
106	Do you have a contract with the project? Which ones?	Border tree planting	Planting fruit trees in the yard mamunda	pigeon pea planting	Ferdebia planting	woodlots	Cashew nut fruit orchard/
		mango fruit orchard	Non burning machambeas	Drip irrigation	Forest management		
107	How much money did you get paid the first year you have entered into contracts?						
108	How much money are you being paid each year (since getting a contract)?						
109	How did you spend that money?						
	Social response to the project						
110	Did the trees you have planted made a difference to the productivity of your land?						
111	What it the best thing about the new way of farming?						
112	What it the worst thing about the new way of farming?						
113	Why did you get involved with the project?						
114	Do you know why you are being paid to plant trees?						

[14] If the respondent is not forthcoming we can list them Timber – Rope- Mushrooms - Roots and tubers - Wild animals – Rats - Fruits & nuts – Bee's Wax – Honey – reeds – bamboo – Grass – Medicines - Construction poles - Firewood

115	How did this money coming in affect the community?	
116	Did it make the situation in the village better or worse? Why?	
117	Did it change the way people relate to one another?	
118	What is the best thing about the project?	
119	What is the worse thing about the project?	

FOLLOW UP QUESTIONS

120	If fire inside: how big is the space?	10 m3	20m3	20+
121	Quantity of food per meal (weight)		Lunch	
122	Fire wood – did you use live wood before Envirotrade intervention?			
123	What else do you use wood that you collect for?	Building/poles	Artifacts	Medicine/charcoal
124	IN which quantities?			
	Weigh/count them			
125	Which tree species do you use for that?	Building/poles	Artifacts	medicine
126	Which part of the tree do you take from – trunk/branch/twigs?[15]			
127	Where do you collect the wood from?			
128	What do you think are the drivers of deforestation?			

SEMI- STRUCTURED INTERVIEWS (Sena version)

N°	Question	Answer		
Socio economic assessment (defining clusters)				
129	Muri vangasi pamuhi	0-5	6-10	11-15
1130	Muna vana vangasi vari pasi pegumi ramakore?			
131	Mudabarwa muno munhambita	Ndizvo/kabe	Quando kabe muda bukakuponi	Muda tanga rini kukara munhambita? Tangue ranji?
132	Vabereki vadabarwa muno munhambita	Ndizvo/kabe	Quando kabe, vadabuka kuponi?	Vadatangisa rini/chaka kukara munhambita? Tangue ranji?
133	muna vakazi vangasi pamuhi.?		Muda vavaka chaka chiponi	Mudzimai mubodzi anevana vangasi?
134	Vakadzi vanu maoriginario amuno munhambita?	Ndizvo/kabe	Quando kabe, vadabuka kuponi?	Vadatangisa rini/chaka kukara munhambita? Tangue ranji?
135	Pazvichaka zvishanu zvapinda mudatamikirwa nehama kana kabe?		Ndizvo/kabe	Munhu vepannumba.Family.	chanhi chidadachitisa.
136	Pane zvivakwa zvingasi patireno yanu? (inhumba/pakukoyera)			
137	munazvinhu zvakukosha zvinachengeteka zvingasi?nembani (wachi,bisikareta,zvakushandisa kumunda,zvekuvezesa,nezvimweniwo)			
Machambas				
138	muna minda mingasi?	Munda/Machamba 1.	Munda/Machamba 2.	Munda/Machamba 3.
139	Matoma chaka chiponi.			
140	Ndiani anarima mwenemo?			
141	Chani chima pariva mwemo?			
142	Produto muda produzir chaka chamara?			
143	Tangue ranji muda decidir kuparira zvirimwa zvenezvo,ndechipi chirimwa chinakosha?			
Inputs				

[15] In order to assess whether renewable or non renewable

144	Muna tenga mbeu?Did you buy seeds? Muna tenga conta yanji para munda mubodzi			
145	Muna sisystema irrigacao?zvida kuitirai conta yanji?			
146	Munashandisa dubro?Do you use fertilizers? (kana muchishasa,munashandisa tipo iponi oganico/chemico.)			
147	Munashandisa mutombue vekuuraya zvirombo?Do you use pesticides? (kana muchiika munaikaoganico kankemica?)			
148	Muda pagari munhu para kushanda mumaminda/vanhu vangasi munavapagari conta yanji pamwedz?			
149	Mari zidabudisa imwe mumaminda chaka chamara?			

Burning regime			
150	Muna pisa maminda mukamara kupunga?	Munapisa munda veseni kana padoko?w	Mwezi dziponi/kangasi?
151	Mbani anopisa/akapisa?		
152	Chani chidachitika kumiti iri mumaminda panu muda pisa??		
153	Muna koya sei moto vanu para kuti usamhuka kuna dzinango mbuto?		
154	Muda siya munda mutembo dzidamara?		
155	Muchiri kuhwirirazve kumunda vanu vekare?		

Income from farming					
165	Muda gurisa zvinango zvanu mudaproduzir chaca chamara(zvakumenha&nechero)	Conta yanji chibodzi?	Kuponi? ? Mercado/comunidade/kunango.market/village/other	Kuna ani?	Dinhero zanhu makubudisa?
	Rice				
	Sorghum				
	Bananas				

Non timber forest products harvested							
157	Michera iponi yanumunakorora mutsanga. (Zvinhu zvakufunika)(by order of importance)[16]						
158	zvidawanda tani?						
159	Muhigurisa produto? Kupohi? Nuda gurisa zvida vandal tani?						
160	Mudabudisa conta yanji paproduto yechaca chamara?						
161	Nzira dzinango dzinakupasani dinheiro?	Magacha	Basa ranu munoramba muchita?	Kugurisa zvakubikwa	Kugurisa zvinango zvanu munagadzira(zviponi)	Kugadzira marasha.	Zvinango
162	Dinheiro zidabuda chaca chamara?						

163	Muda gura comida chaga chamara ?	Kmponi?	Produto iponi chaca chamara?	Muda shandisa dinerho zingasi?
164	Mudambo dever dinheiro chaga chamara ?	Conta yanji?	Mbani uda kupasa?	Chikari chimbadzwa para Conta yanji?

[16] Madeira – rudzi – chova – midzi – muka dzamutsanga – mbeya – michera – xxx – uchi – uska – masengere – xxx – midzi – miti yekuyakisa - nkuni

Carbon income							
165	Muna contracto na projeto? Iponi?	Machekamiti mumucheto mamunda	Muda checka miti yama fruto pateremo yanu	Kucheka mbueti	Kucheka Ferdebia	Kucheka Miti para kushan adisa	Kucheka Cashew nut?
		Kucheka Manga?	Muri kupagar mi para kutimusa pisa munda	Systema irrigacao	Muri kupasaiv a mari para kuti mukove tsanga		
166	Conta yanji ida pagarwi imwe chaca chakutoma?						
167	Conta yanji iri pagarwi imwe pachaca?						
168	Muda itanji nadinhero zanu mudapasiva?						
169	Projeto haisiri kucriar maproblema kuvanhu?						
170	Dinhero izi dzidaya communidade padatani? Did it make the situation in the village better or worse?						
171	Ida batsira communidade kana kabe? Tangue ranji?						
172	Ida mudar magariro avanhu communidade ?						

4.3 Responses to the introduction of wood stoves in Nhambita/Chicale Regulado (n=20)

SEMI- STRUCTURED INTERVIEWS (English only[17])

Date of interview_____ Location of house (GPS)_____

Name of interviewee_____

N°	Question	Answer					
"Protocol" on the use of wood stoves							
173	Who uses the stoves in general?	Name (F/M)		Age		Family member	
174	Who else uses the stoves occasionally?	Name (F/M)		Age		Family member	
175	Do you use the stove to cook meals for other people?	For whom?		How often?		What?	
176	How many times have you used the stove?	< 5 times		>5 times		Every day	
177							
New kitchen regime For each of these questions, the respondents will be asked to indicate whether s/he has also been using an open fire							
178	Do you use the stove for each meal or some of the meals (indicate hw systematic)	Breakfast x Always x Sometimes x never		Lunch x Always X Sometimes X never		Dinner X Always X Sometimes X never	
179	Has the quantity of food that you cook per meal changed with using the stove? (weight) Why?	Breakfast		Lunch		Dinner	
180	Which one of these fuels	Wood	Dung	grass	Charcoal	Agriculture-	other

[17] By that time of the research, my translator and I decided to have me ask the question in English, which he would translate directly without reverting to his translated script.

	do you use in your stove?					waste (type)	
181	What do you prefer and why?						
182	Where do you prepare your food when you use your stove?	Inside	Outside	Depends/ explain factors			
183	4. How long does it take to cook a meal with your old stove?	<30 min	30min	45min	1 hour	1 h 15	1 hour 30
		1h 45	2 hours	2h 15	2h 30	2h 30<	Don't know
184	5. How long did it take to cook with the stove using wood?	<30 min	30min	45min	1 hour	1 h 15	1 hour 30
		1h 45	2 hours	2h 15	2h 30	2h 30<	Don't know
	How long did it take to cook with the stove using charcoal?[18]	<30 min	30min	45min	1 hour	1 h 15	1 hour 30
		1h 45	2 hours	2h 15	2h 30	2h 30<	Don't know
Quantifying new wood usage with the use of the stove							
185	Do you use only the stove or do you use the stove in combination with an open fire?	Stove only		Only open fire		Stove and fire	
186	Specify how often/on which occasions/for which meals						
187	Why?						
188	How much wood do you use in a day in total (for stove and fire if applicable)? (weigh wood for day)						
189	How much do you use to cook your lunch on the stove? (weigh wood for lunch)						
Health considerations							
190	Is there less smoke in the house with the stove?	Explain					
191	Discussion on smoke (is less smoke a good or a bad thing?)[19]						
New wood collection regime – assessing the new livelihood strategies							
192	Who collects wood (has it changed)?	Name	Age	Male/ Female		Family member	
193	How much wood do you collect at a time? (weigh bundle)						
194	How many head bundles do you collect a week?	Number of bundles & number of sticks per bundle					
195	How often do you collect wood?	Every day	Every 2nd day	Twice a week	Once a week	Once every 2 weeks	Once a month
196	When was the last time you collected wood?	Yesterday	2 days ago	3 days ago	Last week	2 weeks ago	Other
197	How big are the pieces of wood you use for the stove?	Measure – length - diameter					
198	What do you use to cut the wood down with?	Saw	Axe	macheta			
199	Type of wood collected (quantify %)	Dead wood	coppiced	twigs	trunks	grasses	other

[18] This question will only be relevant for the one participant who uses charcoal

[19] The researcher's assumption here is that the lack of smoke could be an issue since smoke is traditionally used to repel insects in the stored maze below which the fire is lit.

200	What species/types do you prefer collecting (order of preference) + reason: less smoke, slow combustion, calorific value)?						
201	Do you store wood to use on the stove?	Yes/no	For how long?	In which circumstances?		In which season?	
202	Do you dry your wood before using it?	Yes/no	Where?		For how long?		
New reachable wood collection area							
203	Where do you collect wood from? (how far, how and where)	0 – 500m		500 – 1000m		1000m +	
204	Do you collect mostly wood from	Ortia or Machambas		Close forest		Far forest	
205	How long does it take to collect wood/trip?	0 – 30 min	31 -60 min	1-2 hours	2-4 hours	4-6 hours	6+ hours
Economics of cooking regime on livelihoods strategies							
206	If you spend less time harvesting wood, what do you dedicate more time to?	cooking	children	work	other		
207	Discussion on time saved?						
Now that you have used less wood… what do you do with the wood left?							
208	There is still a lot of wood available, do you use it, i.e do you still collect as much wood for other purposes?[20]						

ANNEX 5: HOUSEHOLD ID, GPS COORDINATES AND MEMBERS OF HOUSEHOLDS INTERVIEWED

HOUSEHOLD INTERVIEWS IN NHAMBITA

1	**0623441,7900432,1**	**GRACIA FAZENDA & MOSEH SIMONE DOMINGOS**
2	**0623755,7901039,2**	**LINDA SAIMONE**
3	**UNKNOWN**	**ANITA FELIX & SIMAO**
4	**0623587,7899900,4**	**LINDA JORNAL TOLE & MANUL JOSE LUIS**
5	**0623586,7899901,5**	**ANATOLIA DANIEL MABUKU**
6	**0623705,7899029,6**	**CHINGAMOIO ANTONIO J. TOVU & MARIA FRANCESCO**
7	**0623784,7900081,7**	**ZILDA JORNAL MEQUE**

[20] If people use less wood for cooking in a fuel-efficient stove, would they collect less wood, or just use the surplus for lighting and ceremonies?

8	**0623056,7899264,8**	**AGINALDA PITA**
9	**0632592,7898812,9**	**HELENA ALEXO JOHN,**
10	**0623802,7900329,10**	**LURDE, WIFE TO ORLANDO**
11	**0623830,7900405,11**	**MARIA BENTO LUIS**
12	**0623850,7900370,12**	**ROSALIA JONE (WAS GIVEN STOVE BUT DECLINED)**
13	**0624132,7900282,13**	**ABIBA ZACARIAS**
14	**UNKNOWN**	**MARIA MONTEIRO**
15	**0623637,7900414,15**	**FACHIMILIA CHEIA**

HOUSEHOLD INTERVIEWS IN BOE MARIA

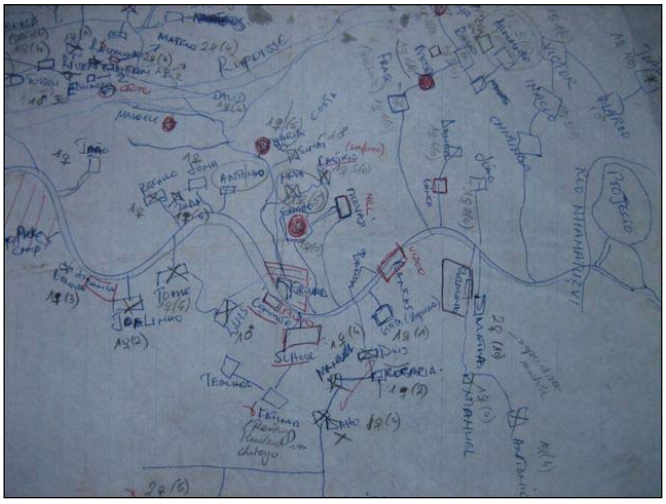
16	**0624162,7896479,16**	**ROSITA LUIS CAMPIRA**
17	**0623982,7896471,17**	**EUGENIA & BERNARDO JOAO**
18	**0623327,7896407,18**	**GENIA & SIMAO BENGAIA**
19	**0622970,7896583,19**	**MARIO & FRANCESCA ALMOCO**
20	**0622400,7896802,20**	**MATHEOS & FORORA JACOBE**
21	**0623135,7896771,21**	**EVENIA & ACELIO VENTURA**
22	**0624004,7896627,22**	**JOAO BERNARDO TANGUE**
23	**0623210,7896385,23**	**MFUMO LUCAS MELO**
24	**0622147,7896968,24**	**ERIKINA BARATO**

25	**0622853,7897120,25**	**GRACA ZACARIAS & MANUEL JINGA**
26	**0622517,7896855,26**	**TEREZINHA LAPSON**

HOUSEHOLDS INTERVIEWED IN MUNHANGANA

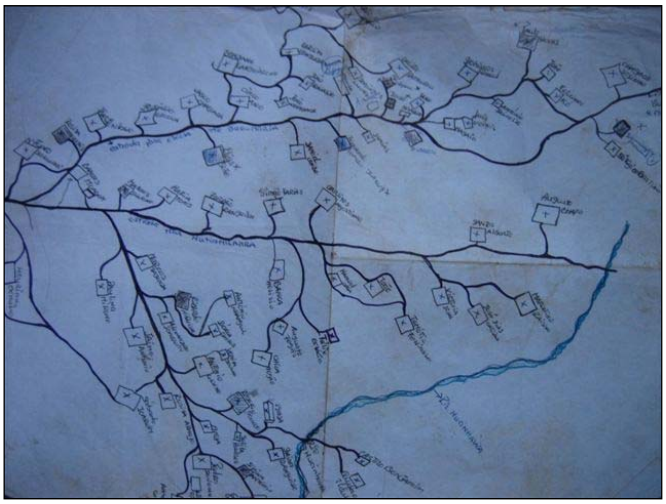
27	**0621151,7898179,27**	**ROSITA VERNIS & ALFONSO DAVID**
28	**0621344,7897477,28**	**AUGUSTO OFESSE & JUANITA BOLAGNA**
29	**0621402,7897364,29**	**FELIZ GILBERTO FERNANDO**
30	**0621895,7897355,30**	**EVA & JORGE ANTONIO JOAU**
31	**UNKNOWN**	**VERONICA ESTASO & DOMINGO MANUEL**
32	**0621182,7897405,32**	**ZERINA HERVEYO & FERNANDO TEMBO JOAQIM**
33	**0621176,7897576,33**	**ANOLIA & ELIAS SETE**
34	**0620766,7898408,34**	**OTILIA FRANCESCA & MARCOS FAZENDA**
35	**0620654,7898475,35**	**RICARDO ORARIA & MOSTINA FRANCISCO QUEMBO**
36	**0620732,7899023,36**	**SPINA ANTONIO & ZUZE LUIG**
37	**0620707,7898683,37**	**BERINA SABADO & ROGERIO FRANCESCO**
38	**0620954,7898180,38**	**MATEUS SEVENE & NORIANA FAZEDA**
39	**0621804,7897428,39**	**AIDA & PAULO NOVAS**
40	**0621725,7897323,40**	**DAINA LUIGI**

ANNEX 6: DRAWN MAPS OF THE STUDY AREA[21]



Map 1: The Nhambita village

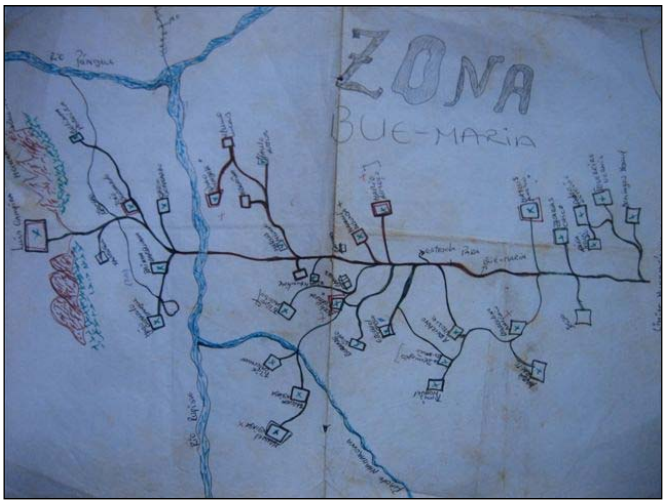
Source: Map drawn by Ranguisse (2009) during the field research



Map 2: The Munhanganha village

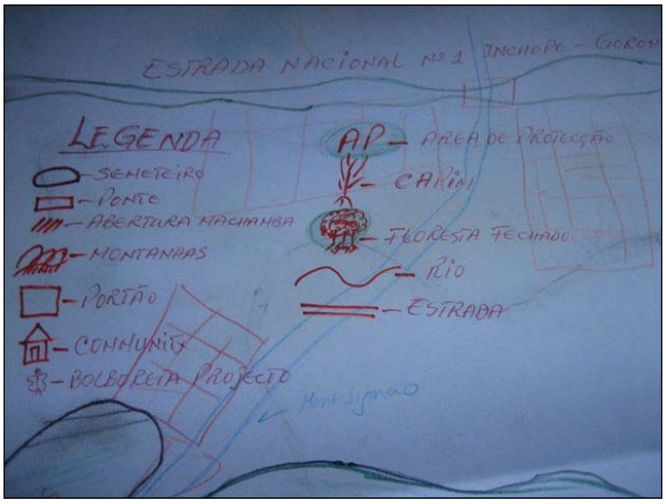
Source: Map drawn by Niquice (2009) during the field research

[21] These maps were used to navigate in the villages. Colored in red are the households randomly selected for the purpose of the research. The maps are not up to scale.



Map 3: Boe Maria

Source: Map drawn by Niquice (2009) during the field research



Map 4: Map produced during the Participatory Rural Appraisal exercise with the men

Source: Compiled by the eight men participating in the exercise.

ANNEX 7: DRAWING USED TO ASSESS USE OF TIME IN THE STUDY AREA[22]

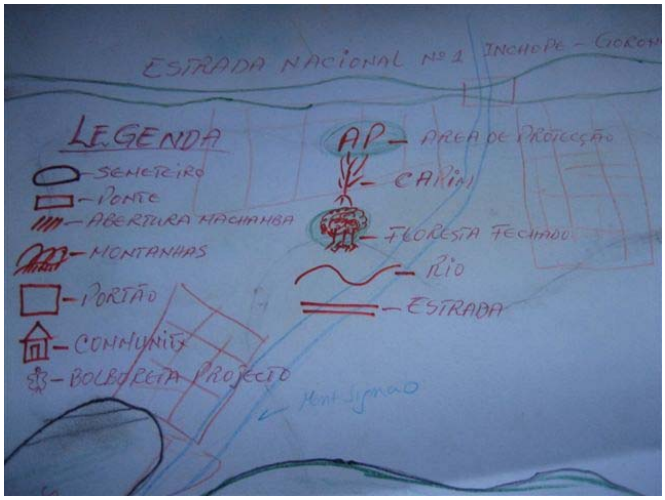


Figure 1: Drawing used in semi-structured interviews with women

Source: author

ANNEX 8: CONTRACT THAT STOVE RECIPIENTS SIGNED WITH ENVIROTRADE WHEN BUYING A STOVE[23]*.*

CONTRATO

A comunidade de Nhambita depende em grande medida dos recursos naturais para a sua sobrevivencia. Esta comunidade depende quase que exclusivamente da lenha para satisfazer as suas necessidades energeticas. Normalmente sao as mulheres que ocupam grande parte do seu tempo a recolher a lenha para a confeicao de refeições. O metodo tradicional de confecionar as refeições é muitas vezes ineficiente em termos de aproveitamento da energia gerada da queima da lenha e produz bastante fumo.
Visando melhorar o aproveitamento da energia gerada pela queima da lenha e deste modo reduzir o tempo das mulheres para a recolha da lenha, contribuir para reduzir a pressao sobre os recursos florestais, reduzir a emissao de gases do efeito estufa e contribuir para reduzir o impacto do fumo na saude da comunidade estao sendo introduzidos a titulo experimental os fogões a lenha melhorados.
Para tal foram inqueridas algumas familias das quais foram seleccionadas 20 que se beneficiarao dos fogões. Estas familias beneficiarias assinarao o presente contrato com a Envirotrade.
É assim que entre a Envirotrade, sediada em Nhambita, representada pelo Sr. Petrus Van Zyl, Coordenador, como primeiro outorgante e _____ de nacionalidade Moçambicana, natural de _____ e residente em_____, como segundo outorgante é celebrado e reciprocamente aceite o presente contrato que se regerá pelas seguintes cláusulas:
CLÁUSULA PRIMEIRA
(Objecto)
As partes convencionaram por acordo que se vai, a titulo experimental, receber e usar o fugao para posteriormente promover o seu uso na comunidade.
CLÁUSULA SEGUNDA
(Vigência)
O presente contrato é por tempo determinado de um ano.
CLÁUSULA TERCEIRA
(Obrigações das partes)
1. São obrigações do primeiro outorgante:
Fornecer o fogão ao segundo outorgante;
Providenciar assistência técnica para educar como usar o fugão;
2. São obrigações do segundo outorgante:
Fazer uso do fogão de acordo com as recomendações tecnicas;

---

[22] Women were asked to allocate seeds proportionally to the amount of time allocated to cooking, farming, fetching water, fetching fire wood, taken care of the children.
[23] According to this contract, people can buy the stove in two installments within a year and commit to further accommodate follow up research on the use of the Stoves.

Prestar informação ao primeiro outorgante sobre os diferentes aspectos tecnicos nomeadamente a eficiencia, quantidade de lenha entre outras;
Fazer o pagamento dos fogões de acordo com o estabelecido na quarta clausula;
CLÁUSULA QUARTA
(Modalidades de pagamento)
Por cado fogão o segundo outorgante pagara um valor subsidiado de 100,Mt (cem meticais). O beneficiario podera pagar este valor em duas prestações durante um ano depois do receber o fogão.
CLÁUSULA QUINTA
(Rescisão)
Qualquer das partes pode a todo o tempo rescindir o presente contrato, desde que não esteja a ser cumprido, por uma das partes, o preconizado neste contrato com enfase nas clausulas terceira e quarta.
CLÁUSULA SEXTA
(Resolução)
Se, durante a vigencia do presente contrato, surgirem litígios ou disputas entre as partes, serão resolvidos em primeiro lugar por recurso a resolução amigável entre as partes. Não sendo possível alcançar concensos o caso será submetido a outras instâncias de acordo com o caso.
CLÁUSULA SETIMA
(Outros)
Os outorgantes trabalharão juntos no sentido de promover a distribuicao de fogões na comunidade.
Nhambita, aos ____ de _____, de 2009

O PRIMEIRO OUTORGANTE O SEGUNDO OUTORGANTE

_____ _____

ANNEX 9: PHOTOS OF THE FIELD RESEARCH

Photo 1: Aerial view of Nhambita

Source: Envirotrade, Photo by Powell, P. 2008:23

Photo 2: Household in Boe Maria. In the foreground: three stone fire, wood collected for one day and maize powder drying in the background

Source: author

Photo 3: A typical three stone fire

Source: author

Photo 4: Fire wood in a *Machamba*

Source: author

Photo 5: Two fires lit within a distance of ten meters

Source: author

Photo 6: Two fires lit within a distance of ten mete

Source: author

Photo 7: Harvest of sesame, a good cash crop in the village

Source: author

Photo 8: Young family by their three stone fire – lunch time

Source: author