



C4
EcoSolutions

9B Mohr Road
Tokai, 7945
Cape Town
South Africa
T/F +27 (0)21 715 1560
info@c4es.co.za
www.c4es.co.za

Improved Cooking Stove Programme (Malawi):

*Calculating the National
Non-Renewable Biomass fraction (f_{NRB})*

*Report compiled by Roland Hunter
C4 EcoSolutions, Cape Town, South Africa
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Introduction

C-Quest Capital is developing carbon offset projects which will distribute Improved Cooking Stoves (ICS) to households that rely on woodfuel. These projects will generate revenue through carbon credits by reducing fuel demand. The non-renewable biomass fraction (f_{NRB}) is a variable used in the calculation of emission reductions (see Box 1). To facilitate the implementation of a C-Quest Capital ICS project, C4 EcoSolutions was contracted to determine the f_{NRB} for the country of Malawi using the Clean Development Mechanism (CDM) methodology^[1].

Box 1

f_{NRB} is the fraction of woody biomass conserved by the project activity in year y that can be established as Non-Renewable Biomass (NRB). It has a range from 0 to 1, where 1 equates to 100% of the woody biomass saved by the project being non-renewable. This is calculated with the following equation^[1]:

$$f_{NRB} = \frac{NRB}{DRB + NRB} \quad (1)$$

where:

DRB = Demonstrably Renewable Biomass (tonnes); and

NRB = Non-Renewable Biomass (tonnes).

Non-Renewable Biomass is the quantity of woody biomass used in the absence of the project activity (B_y) minus the DRB component, and can be calculated using the following equation:

$$NRB = B_y - DRB \quad (2)$$

The Republic of Malawi is a small and densely populated country in southeast Africa. The country is divided into 28 administrative districts within 3 regions – Southern, Central and Northern (Figure 1). It is one of the world's least developed countries, and access to electricity is very low and confined to urban areas^{[2][3]}. Consequently woody biomass fuels (primarily firewood and charcoal) provide ~90% of domestic energy requirements^{[2][3][4][5]}. Deforestation and land degradation is a well-known and publicised issue in Malawi, for which unsustainable charcoal and firewood consumption is frequently cited as a major cause^{[6][7][8]}. An estimated 35% of primary forest cover and 15% of total forest cover was lost between 1990 and 2005^[9]. Deforestation rate is estimated as ~2.8% per year and is thought to be the highest in the Southern African Development Community (SADC) region^[10].



Figure 1: Map of Malawi^[11].

In rural areas, households cook primarily with firewood (96% firewood, 2% charcoal) while urban areas use both charcoal and firewood (43% and 42% respectively)^[3]. Therefore in order to estimate the total annual woodfuel demand for Malawi (B_y), it was necessary to distinguish between urban and rural woodfuel demand. The Malawi Biomass Energy Strategy (BEST) study provided estimates of per capita consumption rate of firewood and charcoal in all 3 regions of the country, and distinguished between urban and rural users^[2]. Consequently these figures were selected as the basis on which to predict woodfuel consumption. Charcoal consumption was converted to reflect equivalent mass of wood by assuming a wood-to-charcoal conversion efficiency of 17.2% for the traditional earth-mound charcoal kilns which are most common in Malawi^{[12][13][14]}. Assumed per capita consumption of woodfuel in urban and rural areas is summarised in Table 1.

Table 1: Estimated woodfuel consumption rate of urban and rural populations in the 3 regions of Malawi (kg/capita/annum)^[2].

Region	Firewood		Charcoal (equivalent wood mass)	
	Rural	Urban	Rural	Urban
Southern	538.6	243.7	51.9	650.9
Central	678.6	377.2	30.3	302.3
Northern	646.3	328.2	34.5	424.0

Population in the 3 regions was estimated by summing district populations derived from the 2008 census study, which provided % population growth rate estimates for urban and rural areas in all regions^[3]. Urban and rural population was multiplied by the per capita fuel consumption rates to estimate total national woodfuel consumption B_y , presented in Table 2.

Table 2: Estimated rural and urban population of the 3 regions of Malawi and total annual woodfuel demand B_y (tonnes/annum).

Region	Population		B_y (tonnes/annum)
	Urban	Rural	
Southern	2 136 561	4 416 345	4 595 965
Central	2 371 666	3 878 685	4 479 772
Northern	1 083 620	863 664	1 348 500
Total	5 591 848	9 158 694	10 424 237

The total annual woodfuel demand for Malawi, B_y , is calculated as **10.4 million tonnes/annum**. The Southern and Central regions account for ~44% and ~42% of woodfuel demand, respectively.

Estimating Demonstrably Renewable Biomass (DRB), Non-Renewable Biomass (NRB) and Fraction of NRB, F_{NRB}

- **Identification of Demonstrably Renewable Biomass (DRB)-producing areas**

Under the CDM methodology, forest biomass is considered to be demonstrably renewable “where:

- a) the land area remains a forest;
- b) sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
- c) any national or regional forestry and nature conservation regulations are complied with.”^[1]

Non-forest biomass is also considered renewable “where:

- a) the land area remains as non-forest or is reverted to forest;

- b) sustainable management practices are undertaken on these land areas to ensure in particular that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
- c) any national or regional forestry, agriculture and nature conservation regulations are complied with.”^[1]

It is anticipated that Malawi’s woodfuel demands are met by a variety of sources, including trees from farms, customary lands, and from within protected areas such as Forest Reserves (FR), Game Reserves (GR) and National Parks (NP). Forests from customary land represent the largest category of Malawi’s forests (~63%)^[15] and are an important source of firewood and charcoal, however these areas are highly disturbed and are increasingly threatened by deforestation^{[10][16]}. In many districts, it is reported that, with the exception of FRs and other protected areas, remaining forested areas primarily occur in graveyards and some community and private-owned forests managed under various initiatives^[10]. The Central and Southern Regions are worst affected, and in some districts mature trees have been virtually eradicated outside of protected areas^[17]. Unregulated production of charcoal on customary lands, although illegal, reportedly continues to be widespread in Malawi^[18]. These observations indicate that woodlands on customary lands have been widely degraded by unsustainable exploitation and do not fulfil the criteria for DRB. Satellite imagery of customary lands adjacent to protected areas such as FRs illustrates the reduction in vegetation cover in communal lands due to unchecked resource exploitation (Annex, Figures 2 – 4). Due to rapid population growth and a high level of dependence on farming and natural resources, Malawi’s population is now challenged by a shortage of customary land. Accordingly, protected areas such as FRs are experiencing increasing exploitation and encroachment^{[18][19][16][20][21]} (also see Figures 3 – 4, Appendix A). Commercial producers and sellers of firewood and charcoal have come to prefer wood from FRs, since the high quality woodfuel provided by Miombo woodlands is increasingly rare in the degraded customary areas^[16]. In consequence, it appears that many FRs are affected by illegal logging and encroachment and do not fulfil the criteria for DRB.

According to the classification system employed by the FAO’s Forest Resource Assessment (FRA) studies, there are no forested areas under a sustainable management plan in Malawi^[4]. According to the International Union for Conservation of Nature (IUCN), there are no protected areas in Malawi that are managed to allow for sustainable use of resources (i.e. Categories 1b, VI)^{[22][23]}. This indicates that most protected areas, which account for the majority of the remaining forests in Malawi, are not eligible as sources of DRB. Identifying other areas which potentially fulfil the criteria for DRB is challenging. Although the national forestry policy has been amended to make allowance for the sustainable production of charcoal (which was previously illegal), the process of becoming registered as a licensed charcoal producer is complex and requires a detailed management plan. According to the most recent documentation that could be found, there is only one registered charcoal producer in Malawi^{[7][24]}.

In order to reduce degradation of woodlands and forests, the policy of Malawi’s Department of Forestry (DoF) was updated to include a community-based participatory approach to management of FRs and customary land^{[25][26]}. The overriding objective of FR management is to ensure that protected areas remain under forest cover. A secondary policy objective is to develop Forest Reserves for sustainable production and use of forest resources that is compatible with the primary objective^{[25][26]}. Each group that wishes to enter into community forest management must form and register as a Local Forest Organisation (LFO), including management arrangements and sustainable harvest plans, and resources within common access areas can be managed by Village Natural Resources Management Committees (VNRMC)^[27]. However, obtaining records of the number and locations of registered community-managed forests is challenging and could not be established for this report.

The Improved Forest Management for Sustainable Livelihoods Programme (IFMSLP) promotes community involvement in forest management and protection in Malawi, and assists in the development of sustainable small and medium forest-based enterprises. In 2011 the IFMSLP had been implemented in 12 districts (Chikwawa, Chitipa, Dedza, Karonga, Kasungu, Machinga, Mzimba, Nsanje, Ntcheu, Ntchisi, Rumphi, and Zomba)^{[28][29]}. An assessment of the IFMSLP by the FAO found that the programme had been successful in developing sustainable management strategies in the targeted FRs and had contributed to ensuring that the availability of forest products and services could be expected to continue on a long-term basis^{[29][30]}.

The forested areas represented by the IFMSLP were considered the only verifiable source of DRB in Malawi. In order to calculate the total volume of wood generated annually by DRB-producing forests it is necessary to estimate the Mean Annual Increment (MAI), which is the annual growth rate of a given vegetation type. With exception of the Dzonzi-Mvai FR in the Ntcheu project area, which includes pine plantations, all FRs in the IFMSLP program primarily comprise Miombo woodland^{[28][29]}. The MAIs of Miombo reserves and pine plantations was calculated as 1.26^{[31][32][33]} and 5.65^[33] tonnes/ha/annum respectively. The product of forest area and MAI is total DRB generated per annum. The total area and MAI of IFMSLP forests is summarised in Table 3.

Table 3: Sum of forested areas and annual production of biomass (DRB) from IFMSLP areas. These forested areas are interpreted as the primary sources of DRB in Malawi.

Region	District	Forest Reserves	Forested area (hectares)		Total DRB (tonnes/ annum)
			Miombo	<i>Pinus</i> plantation	
Central	Dedza	Mua-Livulezi	12 147		15 320
Central	Kasungu	Chawa	538		679
Central	Ntcheu	Dzonzi-Mvai	8 292	3 164	28 336
Central	Ntchisi	Ntchisi	9 720		12 259
Northern	Chitipa	Mughese, Wilindi and Matipa	2 703		3 409
Northern	Karonga	Vinthukutu and Karonga South Escarpment	13 134		16 565
Northern	Mzimba	Mtangatanga and Perekezi	25 140		31 707
Northern	Rumphi	Uzumara	596		752
Southern	Chikwawa and Thyolo	Unknown	117 790		148 557
Southern	Machinga	Liwonde	295		372
Southern	Nsanje	Matandwe	26 205		33 050
Southern	Zomba	Malosa and Zomba	14 536		18 333
Total			234 260	3 164	309 337

Non-renewable biomass, NRB, is calculated as the difference between B_y and DRB. These calculations are summarised in Table 4.

Table 4: Summary of Annual Woodfuel Demand (B_y), Demonstrably Renewable Biomass (DRB), Non-Renewal Biomass (NRB) and Fraction of Non-Renewable Biomass (F_{NRB}) for the country of Malawi.

Region	By	DRB	NRB	F _{NRB}
	tonnes/annum			
Central	4 595 965	200 311	4 395 653	0.96
Northern	4 479 772	56 593	4 423 178	0.99
Southern	1 348 500	52 432	1 296 068	0.96
Total	10 424 237	309 337	10 114 900	0.97

NRB for Malawi is calculated to be **10.1 million tonnes/annum**. F_{NRB} , the fraction of woodfuel that is source from non-renewable sources, is consequently calculated as **0.97**, indicating that 97% of Malawi's woodfuel is obtained from net non-renewable sources.

The following indicators support the conclusion that woodfuel demand for Malawi is met by net non-renewable sources^[1]:

- Households reportedly have to travel increasing distances and switch to lower quality wood in response to local wood shortages^[34].
- A policy brief by the Forest Governance Learning Group indicated that rural women spend up to 8 hours per week collecting firewood^[7]. A survey of rural women found an average time for firewood collection trips of ~240 minutes every 3.8 days^[35].
- Charcoal producers report that production sites have moved further away from densely-populated urban areas due to scarcity of trees^[36]. Reportedly, charcoal producers will walk as much as 50 km from Blantyre to Mwanza in order to find suitable trees for charcoal production^[36].
- Extensive deforestation and clearance of vegetation in publicly accessible areas is evident in satellite imagery (see Figures 2 – 4, Appendix A).

It is likely that a well-implemented ICS project will reduce deforestation in Malawi by reducing the domestic use of woodfuel.

References cited:

- [1] UNFCCC (2011) Energy efficiency measures in thermal applications of non-renewable biomass. Methodological guideline. Series: Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories (II.G./Version 03). UNFCCC: Copenhagen, Denmark. 5 pp.
- [2] Government of Malawi (2009) Malawi Biomass Energy Strategy. Government of Malawi: Lilongwe, Malawi.
- [3] NSO (2008) 2008 Population and Housing Census: Preliminary Report. Statistical Review. National Statistical Office: Zomba, Malawi. 35 pp.
- [4] FAO (2010) Global Forest Resources Assessment 2010: Country Report Malawi. Country Report. Series: Global Forest Resources Assessment (FRA2010/122). Forestry Department, Food and Agriculture Organisation of the United Nations: Rome, Italy. 51 pp.
- [5] Hardcastle, P (1988) Final report on the research component of the second wood energy project, Malawi. Oxford Forestry Institute: Oxford. 29 pp.
- [6] Abbot, J.I.O. and Mace, R. (1999) Managing Protected Woodlands: Fuelwood Collection and Law Enforcement in Lake Malawi National Park. Conservation Biology, 13(2),418–421.
- [7] FGLP. Sustainable charcoal production by and for local communities. Malawi Policy Brief No. 1. Forest Governance Learning Group. Available from: <http://pubs.iied.org/pdfs/G03128.pdf>.

- [8] Kambewa, P., Mataya, B., Sichinga, K., and Johnson, T. (2007) Charcoal: the reality. International Institute for Environment and Development. Available from: <http://pubs.iied.org/pdfs/13544IIED.pdf>.
- [9] IL. (2010) Malawi Profile. Illegal Logging. Available from: http://www.illegal-logging.info/approach.php?a_id=153.
- [10] USAID (2006) Case studies on successful Southern African NRM initiatives and their impacts on poverty and governance. Country study: Malawi. Community partnerships for sustainable resource management (COMPASS) in Malawi: its impact on poverty and governance. USAID Programme, Malawi.
- [11] Maps of the World (2007) Malawi Political Map. Available from: <http://www.mapsofworld.com/malawi/maps/malawi-political-map.jpg>.
- [12] Chidumayo, E.N. (2011) Environmental impacts of charcoal production in tropical ecosystems of the world. Available from: http://www.charcoalproject.org/wp-content/uploads/2011/08/2_Chidumayo_Impacts_tropical_ecosystems.pdf [Accessed September 29, 2011].
- [13] Herd, A.R. (2007) Exploring the socio-economic role of charcoal and the potential for sustainable production in the Chicale Regulado, Mozambique. Master of Science, University of Edinburgh.
- [14] van Beukering, P., Kahyarara, G., Massey, E., di Prima, S., Hess, S., Makundi, V., and van der Leeuw, K. (2007) Optimization of the charcoal chain in Tanzania. Poverty reduction and environment management programme, Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands. Available from: <http://www.prem-online.org/archive/15/doc/PREM%20WP%2007-03.pdf>.
- [15] Bekele, M. (2001) Forestry Outlook Studies in Africa (FOSA) Malawi. Series: Forestry Outlook Studies in Africa. Food and Agriculture Organisation of the United Nations: Rome, Italy. 33 pp.
- [16] Nangoma, D. and Nangoma, E. Climate change and adaptation strategies: a case study of the Mulanje Mountain Forest Reserve and its surroundings. Available from: <http://pubs.iied.org/pdfs/G02311.pdf>.
- [17] RIPPLE Africa (2012) General Information about the Environment in Malawi and Deforestation in Africa. Available from: <http://www.rippleafrica.org/environment-projects-in-malawi-africa/deforestation-in-africa>.
- [18] Luhanga, J. (2009) Malawi: The timber trade. South African Resource Watch. Available from: <http://www.africafiles.org/article.asp?ID=20978>.
- [19] Birdlife International. (2012) Important Bird Areas factsheet: Mount Mulanje Forest Reserve. Available from: <http://www.birdlife.org/datazone/sitefactsheet.php?id=6680>.
- [20] Wildlife Action Group (2012) Thuma Forest Reserve. Available from: <http://www.wag-malawi.org/nav/projects/thuma.html>.
- [21] Carnivore Conservation Malawi (2008) Anti-Poaching. Available from: <http://www.carnivoreconservationmalawi.org/anti%20poaching.html>.
- [22] IUCN (2011) World Database of IUCN Protected Areas. Available from: <http://www.wdpa.org/> [Accessed June 9, 2011].
- [23] IUCN (2011) IUCN Protected Area Management Categories. Available from: http://www.iucn.org/about/work/programmes/pa/pa_products/wcpa_categories/ [Accessed August 19, 2011].
- [24] Masina, L. (2009) The charcoal conundrum. African Business, 320, pp. 74 Available from: <http://www.allbusiness.com/environment-natural-resources/natural-resources-management/11783879-1.html>.
- [25] Government of Malawi (2001) A guide to community-based forest management in Malawi. Department of Forestry, Government of Malawi.
- [26] Government of Malawi. (2003) Community Based Forest Management - a supplement to the National Forest Policy of Malawi, 1996. Department of Forestry, Government of Malawi.

- [27] Government of Malawi. (2007) Guide to the Registration of Local Forest Organisations. Department of Forestry, Government of Malawi. Available from: http://www.ifmslp.org/reports/gov_guide_to_registration_of_lfo.pdf.
- [28] IFMSLP (2011) Improved forest management for sustainable livelihoods programme. Available from: <http://www.ifmslp.org>.
- [29] EEAS. Improved Forest Management for Sustainable Livelihoods Project Overview. European External Action Service, Delegation of the European Union to the Republic of Malawi. Available from: http://eeas.europa.eu/delegations/malawi/projects/list_of_projects/17417_en.htm.
- [30] McConnell, R., Sibale, B., and Utila, H. (2007) Linking national forest programmes and poverty reduction strategies - Malawi. Food and Agriculture Organisation of the United Nations, Rome. Available from: <http://www.fao.org/forestry/16680-0b204abc81cb6ebb6b8e2dda1b981078d.pdf>.
- [31] Kambewa, P. and Utila, H. (2008) Malawi's green gold: challenges and opportunities for small and medium forest enterprises in reducing poverty. International Institute for Environment and Development, London, United Kingdom. Available from: <http://pubs.iied.org/pdfs/13545IIED.pdf>.
- [32] Campbell, B.M., Grundy, I.M., and Matose, F. (1993) Tree and woodland resources- the technical practices of small-scale farmers. In: Living with Trees: Policies for Forestry Management in Zimbabwe. World Bank: Washington, DC, 29–62.
- [33] IPCC. (2003) Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF). Intergovernmental Panel on Climate Change: Vienna, Austria.
- [34] Brouwer, I.D., Hoorweg, J.C., and Van Liera, M.J. (1997) When households run out of fuel: responses of rural households to decreasing fuelwood availability, Ntcheu District, Malawi. World Development, 25 (2), 255 – 266.
- [35] Biran, A., Abbot, J., and Mace, R. (2004) Families and Firewood: A Comparative Analysis of the Costs and Benefits of Children in Firewood Collection and Use in Two Rural Communities in Sub-Saharan Africa. Human Ecology, 32(1),1–25.
- [36] Lupick, T. and Kasakura, A. (2011) Malawi: Changing climate compounds environmental degradation. Inter Press Service News Agency, Africa. Available from: <http://www.ips.org/africa/2011/11/malawi-changing-climate-compounds-environmental-degradation>.

Appendix A

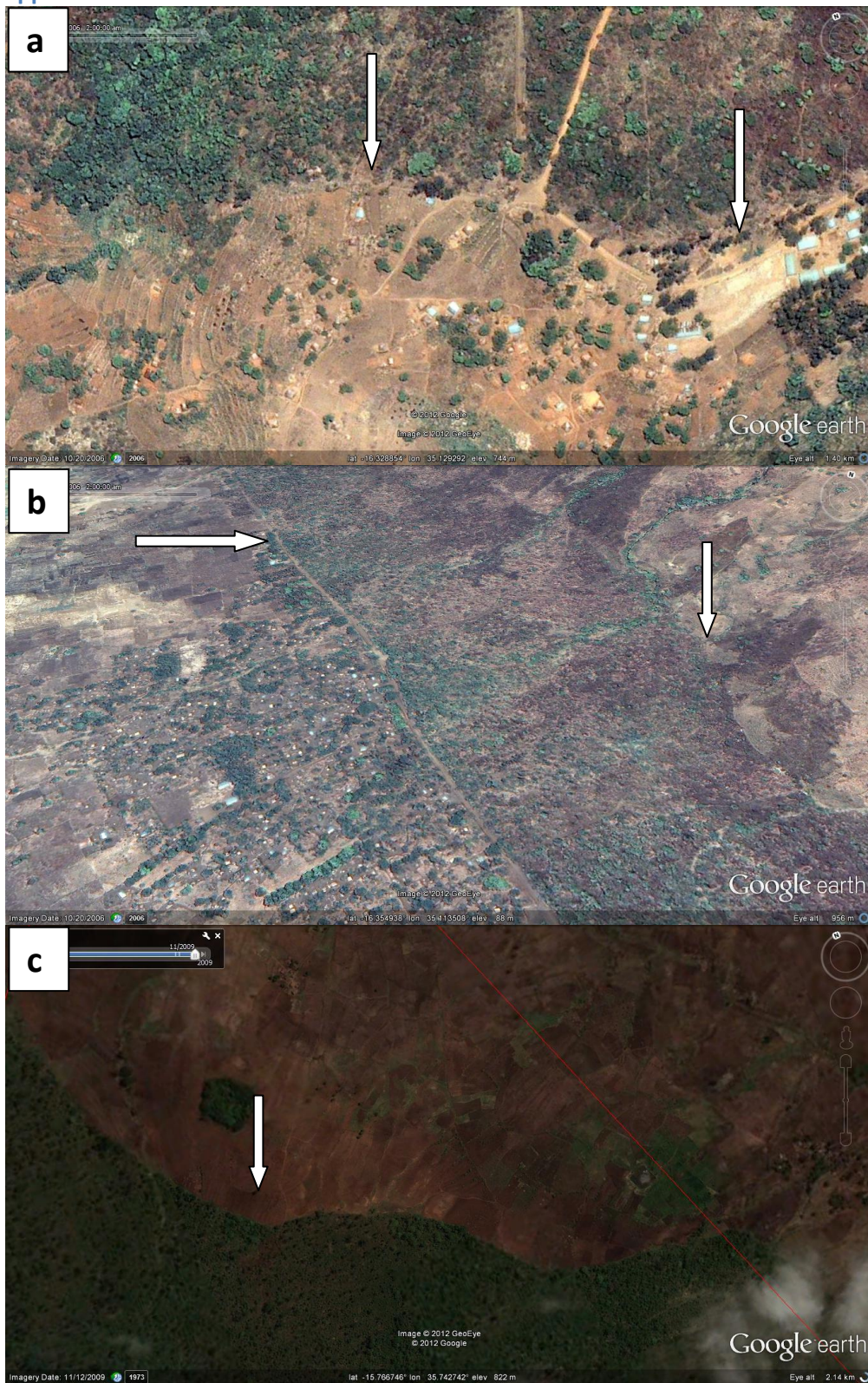


Figure 2.a – c: Extensive deforestation and clearance of vegetation at the border of a) Kalulu Hills (2006); b) Masenjere (2006); and c) Mulanje Forest Reserves (2009). Significant changes in vegetation type and density can be distinguished at the border between Forest Reserves and unprotected areas (marked by arrows)



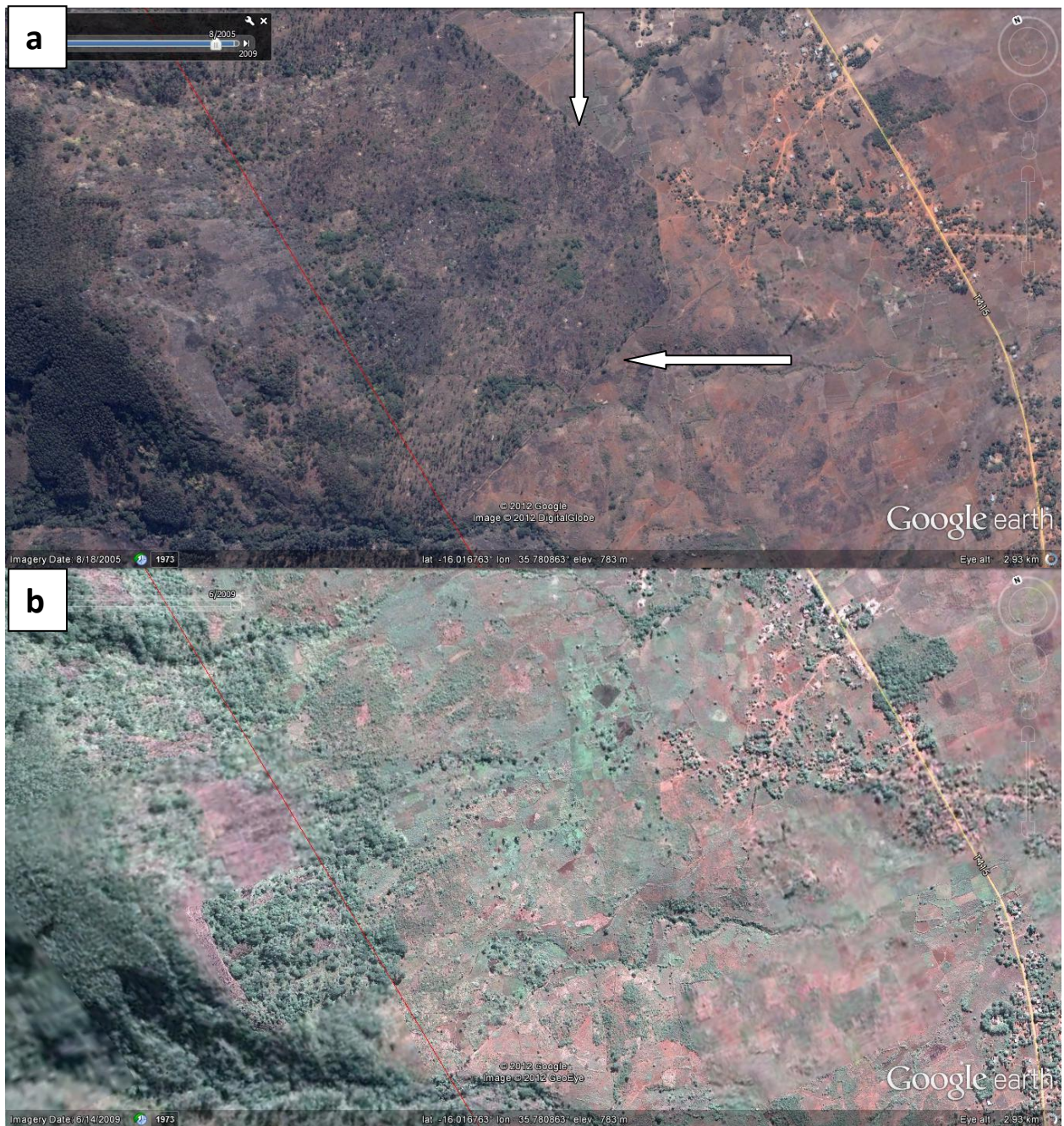


Figure 3.a – b: Vegetation changes at the border of Mulanje Forest Reserve between the years of a) 2005 and b) 2009. The original borderline of the Reserve can be easily distinguished in a), marked by arrows.





Figure 4: Deforestation inside the boundary of Mulanje Forest Reserve (marked by arrow) (2009).



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