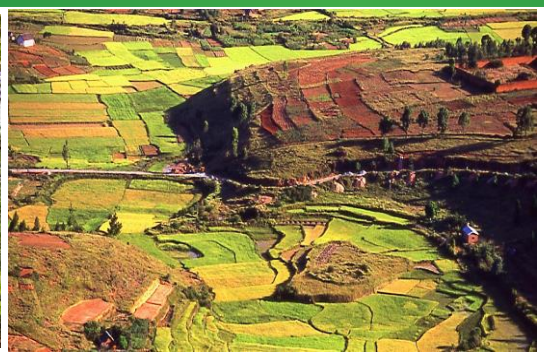
PLATFORM FOR STAKEHOLDERS IN AFRICAN FORESTRY

POLICIES AND OTHER RELATED ISSUES TO THE NEXUS FOOD-FUEL-FIBRE PRODUCTION IN THE CONTEXT OF CLIMATE CHANGE IN SOUTHERN AFRICA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Policies and other related issues to the nexus food-fuel-fibre production in the context of climate change in Southern Africa

Dennis Kayambazinthu

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Acronyms and Abbreviations

3Fs	Food, Fuel, Fibre
AFF	African Forest Forum
BEFS	Bioenergy and Food Security (FAO)
BERL	BioEnergy Resources Ltd
CDM	Clean Development Mechanism
CEMAC	Economic and Monetary Community of Central Africa
CFTA	Continental Free Trade Area
CH4	Methane
CIFOR	Centre for International Forestry Research
CO	Carbon monoxide
CO2	Carbon dioxide
COMESA	Common Market for Eastern and Southern Africa
DRC	Democratic Republic of Congo
EAC	East African Community
ECOWAS	Economic Community of West African States
EI	Extractive Industries
ESMAP	Energy Sector Management Assistance Programme (World Bank)
EU	European Union
FAO	Food and Agriculture Organisation
FD	Forestry Department
FRA	Forest Resources Assessment
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information System
ha	hectare
HH	Household
HFCs	Hydrofluorocarbons
IDRC	International Development Research Council
Kg	Kilogramme
L	Litre
LPG	Liquid Petroleum Gas
Mill.	Million
NAFTA	North American Free Trade Agreement
NGOs	Non-Governmental Organisations
N2O	Nitrous oxide
NOCZIM	National Oil Company of Zimbabwe
PFCs	Perfluorocarbons
RECs	Regional Economic Communities
REDD	Reducing Emissions from Deforestation and Forest Degradation
RIDMP	Regional Infrastructure Development Masterplan
RSA	Republic of South Africa
SACU	Southern African Customs Union
SADC	Southern Africa Development Community

SFM	Sustainable Forest Management
SF6	Sulphur hexafluoride
SSA	Sub Saharan Africa
t	Tonne
TFTA	Tripartite Free Trade Area
UN	United Nations
UNEP	United Nations Environmental Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WAEMU	West African Economic and Monetary Union
Yr	Year

Acknowledgements

This report draws on the work conducted in Malawi, Madagascar, Zambia and Zimbabwe, representing Southern African regional community. The work was funded by the African Forest Forum (AFF). I am grateful to the many people listed in Appendix 2 of this report, who gave their invaluable time and space to share information and discuss issues, which have enormously contributed to the production of this report. Special appreciation goes to the contact persons in each country visited for all the logistical and administrative arrangements, including organising meetings with different stakeholders. In a special way, the following individuals deserve mention due to their significant contribution in providing information needed in this assignment: Alastair Anton and Davies Kashole of Forestry Department in Zambia; Darlington Duwa, Abedinigo Marufu and Stephen Zingwena of Forestry Commission in Zimbabwe; and Lydie Raharimaniraka of Ministry of Environment, Ecology, Oceans and Forestry of Madagascar. I am also indebted to Henry Kadzuwa and Mustaffa Kaunde from the Department of Forestry in Malawi and Mike Chirwa from Forestry Research Institute of Malawi for shouldering part of the work towards completion of this report. Last but not least, I am greatly humbled by the unflinching, invaluable professional direction and technical input from the leadership and management of AFF that shaped the outcome of this report, for which I am truly grateful.

EXECUTIVE SUMMARY

BACKGROUND

The global advancement and investments in biofuels production, consumption and trade are widely regarded as offering environmentally-sustainable solutions to reducing harmful greenhouse gases (GHG), poverty reduction, food and energy security, rural development and employment in developing countries. However, biofuels may also lead to food insecurity, environmental degradation, loss of biodiversity habitat, human displacement; land use and land cover change in situations where policy and institutional frameworks are poor. It is against this background that the AFF instituted this study to investigate and understand the biofuels industry in the selected countries of southern Africa namely: Madagascar, Malawi, Zambia and Zimbabwe, its interplay within the nexus food-fuel-fibre (3Fs), as influenced by the existing policy and institutional frameworks. Specifically, this study sought to address the following key result areas:

1. assessing trends in forest cover change in selected hotspot areas of respective sub regions;
2. assessing and documenting impact of extractive industries (timber, mining, charcoal making, etc.) on the 3Fs in the context of climate change;
3. examining how the competition on biofuel production impact on food production, land security and biodiversity habitat;
4. analysing the mechanisms supporting/incentivizing the production and commercialization of biofuels and the countries specific socio-economic contribution;
5. evaluating policies, legislations and other factors influencing land shifts between the 3Fs and blending of liquid biofuels and fossil fuels and implications on carbon in the context of climate change;
6. assessing fuel-wood and charcoal policies and other practices that will make fuel wood and charcoal industry a viable business at national and sub-regional levels;
7. analysing strategies that will help tracking changes in the levels of production and consumption of fuel wood and charcoal; and
8. providing appropriate key recommendations in relation to the outlined tasks.

METHODOLOGY

Data collection involved both primary and secondary sources on key result areas by reviewing existing literature, regional and country reports, documents on policy and legislation, strategies and plans, and conducting open-ended country interviews with officials from relevant government agencies, stakeholders from the private sector, non-governmental organisations (NGOs).

FINDINGS AND RECOMMENDATIONS

Key findings and recommendations from the studies are as follows:

Trends in forest cover change

- Similar to the global trend, there has been a general decline in forest cover in Southern Africa, with a 20-year (1990-2010) net forest loss being the highest in Africa. FAO's 2007 estimates for the period between 2000 and 2005, show the rates of national deforestation across the region to vary between 0.2% in Angola and 1.7% in Zimbabwe; with those for the countries under study falling within this range, i.e. 0.9%, 0.9% and 1.5% for Malawi, Zambia and Zimbabwe respectively and 0.5% for Madagascar as per United Nations Environmental Programme's (UNEPs) 2012 estimate for the same period.

- However, Food and Agriculture Organisation's (FAO's) 2005 to 2012 estimates (cited in SADC, 2015) show that the deforestation rate more than doubled for Malawi and Zambia from 0.9 to 2.4% and from 1.0% to 2.4%, respectively, although the regional rate only increased by an average of 0.46%. Regardless of the disparities between countries, these figures signify a continued loss of forest goods and services and thereby reduced opportunities for national and regional socio-economic development.

- These deforestation rates, which closely match those from a few selected forest hotspots identified per country, reveal different and complex interplay of drivers of deforestation specific to the identified hotspots and more generally outside them. These are primarily due to conversion of forested areas to agriculture and settlements; extraction of fuelwood for household, urban and industrial purposes; commercial/illegal logging and timber extraction; and infrastructure development.

- Policies, legal frameworks and associated factors have been identified as important underlying factors of deforestation, due to:

i. policies and acts of legislation on agriculture, forestry and energy are just being introduced or in process of formulation and development, e.g. the case of Zimbabwe, where no formal policies on agriculture and forestry currently exist;

ii. some policies are characterised by widespread failure in terms of implementation and enforcement, and

iii. lack of political will, political interference, vested interests and corruption, agricultural subsidies, low levels of government support, weak implementing institutions, independent and uncoordinated operations of sectors, lack of synergies, overriding policies such as on mining over forestry, and inconsistencies in both policy and legislation.

Impacts of extractive industries

Extractive industries (EI) have been identified to form the backbone for accelerated socio-economic development in the southern Africa region, while in some cases having devastating consequences in loss of biodiversity, heavy climatic, environmental and social footprints, particularly when extracted from environmentally fragile areas and where governance and its attendant policy and legal frameworks are poor.

- The mining and minerals EI remain strong in Zambia, Madagascar and Zimbabwe (with that in Malawi still in its infancy), with prospects for greater economic growth though posing serious challenges to sustainable forest management (SFM), provision of the 3Fs, being destructive to the environment and to climate change. For example, there has been a general increase in prices of food and other commodities (such as fuel and fibre) at Kayelekera Uranium Mine in Karonga, Malawi, due to increased mining operations.

- Legislatively, mining is hierarchically given top priority and overrides other legislations such as forestry, such that large tracts of natural forests have been cleared (e.g. in Zambia) to provide land for agriculture and resettlement of laid off miners due to the global copper price downturn.

- The region's increased production, commercialisation and consumption of charcoal and firewood is triggered and exacerbated by increases in petroleum-based fuel prices and electricity tariffs, frequent electricity load shading and increased urbanisation (at 4.0%, 4.7%, 5.3% and 2.5% for Mozambique, Tanzania, Malawi and Zambia respectively). Its significant contribution to national economies (e.g. gross domestic product (GDP) of 3.7% and 3% for Zambia and Malawi respectively), household incomes and employment is leading to even greater demand.

- To overcome the low rates of conversion efficiency of wood to charcoal production, the region has developed surface earth kilns with ventilation channels, e.g. the Casamance kiln, stand-alone brick kilns and metal kilns, though these are too few to make a positive impact and must therefore be promoted.

- Policy reviews underway, are aimed to minimize forest losses, develop and implement sustainable methods of extraction and utilization by improving efficiency technologies are viewed important strategies.

- Timber extraction for industrial roundwood, sawnwood, wood-based panels, pulp and paper, has been observed to contribute to national economies in the region but also resulted in forest depletion, encroachment and conversion to other land uses, among other negative changes, due to a number of policy and governance issues. Changes have therefore been proposed, such as change of forest management and control from government to the private sector, evidenced as one of the important and viable strategies for the region.

- Policy-science interface divide has been observed as widening across the region, with lack of policy direction and political will largely responsible for limited implementation of science-generated results. The region urgently needs to develop programmes to address this problem in order for the region to make progress towards viable and sustainable biofuels production. Alongside this, the region is deemed to have requisite technological and management prescriptions for viable biofuels industries and what is needed is the necessary political will and institutional support.

Competition on biofuel production

Being net importers of fossil fuels, countries in the region see the bio-fuels sector as potentially reducing dependence on imported petroleum products and thus stabilise fuel prices, ensure fuel security; reduce poverty and create employment. However, rapid growth in demand appear to give rise to competition between land for biofuels and land for food production.

- The region is deemed to have suitable ecological and climatic conditions, with generally fertile soils for production of a wide range of bio-fuel feedstocks, with land regarded as abundant and therefore not likely to disturb food production. Though there are potentially a number of feedstocks in the region, the bulk of investments is mainly for bio-ethanol and bio-diesel from sugarcane and jatropha, respectively.

- Though the study established a growing sugarcane industry producing molasses as a by-product used to produce bio-ethanol, which is blended with imported fuel at an average of 20% across the region, production of bio-diesel from jatropha is rather

limited. The latter requires considerable areas of land to be economically viable, with issues of competition with food production and land security, amidst other challenges, having either stalled or completely halted its production. Such challenges appear not that obvious for sugarcane, though the study alludes to some level of competition with the growing of rice, which thrives in similar growing conditions.

- Most countries in the region do not have specific enabling bio-fuels policies and only rely on provisions or general statements on biomass or renewable energy as stipulated in energy policies for their operations. The biofuels industry is therefore regarded as still evolving.

- Countries urgently need to formulate specific policies and strategies informed by empirical research which countries must invest into, to guide bio-fuels development and investment.

Institutional arrangements for development of biofuels

The study revealed considerable variation in what guides and supports the development of the biofuels sector. Specifically, there exist no biofuels policies in all sampled countries and, for a long time, there has not been much movement in this regard other than the revision of energy policies, in spite of Southern African Development Community's (SADC's) institutional support.

- Extenuating governance and institutional setbacks and challenges facing the biofuels sector were observed to relate to:

i. change of governments and frequent cabinet reshuffles, resulting in lack of continuity in biofuels development and implementation of plans;

ii. political interference and conflict of (vested) interests;

iii. several institutions with different mandates, sectoral laws and policies, directly or indirectly influencing the biofuels sector, not being well coordinated and often in conflict;

iv. lack of mainstreaming into sectoral, institutional frameworks and therefore limited supportive environment towards biofuels and climate change issues;

v. lack of national audits on enabling planning mechanisms that should include all stakeholders down to community level, as beneficiaries of any biofuel investments;

vi. well-informed, science-based policy and decision making that would stimulate developments in the biofuels sector; institutional capacity and awareness, particularly on opportunities for small-scale, out-grower schemes and initiatives on biofuels; and

vii. the capacity to develop such programmes; limited institutional knowledge on marketing and commercialization.

- As countries continue to develop the institutional arrangements and requisite biofuel policies and legislative frameworks, consideration of the above institutional setbacks was regarded by most stakeholders as vital for adding value to the process of developing the biofuels sector.

Strategies for development of viable biofuel business

A sustainable and viable biofuels industry requires development of robust policies and regulatory frameworks, including improvements in production and consumption efficiency.

- The bulk of biofuels production in the region particularly firewood and charcoal is from unsustainable sources, with the largest share extracted from open Miombo woodlands, forest reserves, mangrove forests and farm lands.

- Madagascar, Malawi, South Africa and Zambia have had experiences in sustainable fuelwood and charcoal production though currently only Madagascar and South Africa produce these from strategic sustainable sources.

- Madagascar and South Africa have developed integrated, individual, private and community reforestation programmes, applying SFM best practices, with elementary requirement that extraction rates do not exceed present growth rates. Such programmes have created new forest resources through reforestation of degraded landscapes with secure tenure rights; improvement of wood fuel value chain; with enabling policy and legislative frameworks in place.

Policies and institutional frameworks

- Except for South Africa and Mozambique with known policy frameworks, several countries in the region are to varying degrees in the process of developing them to ensure more robust regulatory institutional set-ups as strategies for controlling biofuels production and for enhanced and viable biofuels industry.

- There exists regional institutional policy and legislative frameworks, the SADC Framework for Sustainable Biofuels and the SADC Biofuels Crop Decision Making tool, assisted by FAO's Bioenergy and Food Security (BEFS) initiative.

- Though several SADC member states have used these frameworks to draw up plans to encourage bioenergy development at national level, progress has been slow on implementation for lack of national biofuels policies, strategies and guidelines.

- There is therefore limited national biofuels production value chain in an integrated manner, due to the inadequate inter-sectoral approach involving other natural resource sectors (such as agriculture, mining, energy, etc.) that work in isolation and directly or indirectly influence SFM and biofuels production.

Key recommendations:

(i) Faced with declining forest resources, competition from the mining sector and between 3Fs needs, the growing energy demands and associated GHG emissions, the region must promote the development of harmonised policies and regulatory frameworks for formal trade and investments in renewable energy, energy conservation and energy efficiency critical in reversing the trends in forest loss. This entails for example promoting research and development, mainstreaming of climate change into mining operations, strengthening regional integration in planning and development of renewable energy, including communication and information sharing on renewable energy technologies and enhanced energy infrastructure development.

(ii) In addressing concerns in the biofuels sector, particularly those linked to some of the reported competition and associated impacts on food, land and biodiversity, countries in the region must learn from each other's experiences and use the available evidence where relevant to address such concerns. Though there is indeed every reason to believe that countries in the region operate at different production levels, taking advantage of such evidence might help resolve some of the concerns, for example those related to the out-grower schemes. Progressively, a gradual build-up of similar studies (which must be encouraged) may lead to a comprehensive assessment of possible impacts and serve as a 'stitch in time', particularly when projections of the production and use of biofuels (and presumably related impacts) at global aggregate level point to a four-fold increase by 2035.

(iii) Further studies are needed especially on lesser known feedstocks and the ecological requirements to improve raw material production, as well as investing in their further processing; not overlooking how biofuel production competes with other land uses. With respect to firewood and charcoal, there is a need to develop legally organised sustainable production and marketing systems that will effectively incentivise the actors in this industry in the context of climate change and other emerging issues.

(iv) To overcome low levels of timber production and trade in, for example, round wood and sawn wood, countries need to make substantial progress in trade commensurate

with the available resources by significantly increasing investments or reinvestments and improving capacities in forest production, while at the same time overcoming a number of infrastructural, institutional and governance limitations. This requires concerted efforts by countries in the region, drawing on the success of other countries in the region in wood and wood products e.g. South Africa and Swaziland, through exchange and transfer of technologies and expertise for greater inter-regional integration through SADC and the Common Market for Eastern and Southern Africa (COMESA).

(v) The region needs to revisit the charcoal production value chain at policy and practice levels in an integrated manner, with the explicit purpose to incorporate an inter-sectoral approach and avoid sectors that directly or indirectly influence SFM and charcoal production working in isolation to one another. Given the sectors involved in the whole value chain, there is need for integrated formulation of policies, which should also provide for the effective regulation of the fuel sector through the continuous monitoring of activities of the charcoal industry in relation to prices, trends, and volumes of production and consumption levels.

(vi) Existing trade agreements between countries mainly under the coordination of SADC and COMESA, must incorporate charcoal production and trade, become part of the normal formal trade between countries, in order to move away from the largely informal trade which retards regional efforts for coordinated SFM and compromises efforts in reducing deforestation and forest degradation, curbing environmental degradation and reducing impacts of climate change. The enabling framework that should drive the commitment towards such a paradigm shift should draw on the positive experiences from Madagascar, Namibia and South Africa, and other countries in Sub Saharan Africa (SSA), such as Rwanda, provided there is willingness between countries under the guidance of SADC and COMESA to learn from one another. These would essentially lead the region to minimise forest losses, develop and implement sustainable methods of extraction and utilization of wood fuels by improving efficiency technologies, encourage use of alternative energy sources and use of plantation species in charcoal production.

(vii) Countries in the region must urgently develop programmes to resolve the ever-growing science-policy divide in order for the region and countries in the region to make progress towards viable and sustainable wood production. In this regard, countries in the region have a lot to learn from each other to harness the positive experiences and not ‘re-invent the wheel’ for a viable wood industry. Priority must therefore be given to capacity building of institutions in bio-fuel initiatives across the value chain. In a similar vein, it is highly recommended therefore that bioenergy policies and institutional frameworks be developed informed by rigorous science-based and research-generated information. To this extent, AFF and other

development-oriented regional institutions must develop mechanisms for spearheading programmes designed to narrow the science-policy gap to maximise the use of professionally-generated information for maximum returns on investments both in terms of research and capacity building for enhanced 3Fs production.

(viii) Though dominated by South Africa, the intra-regional trade (of processed forest products, mostly paper, plywood and fibreboards, furniture, doors, fittings and joinery) is highest in the region compared to the other African Regional Economic Communities (RECs). However, trade with the rest of Africa has hitherto been regarded as the lowest, and efforts must therefore be made to improve this trade as well as with the world at large. Indeed, while this trade is regarded as improving and more important for the sub-region, it remains insignificant in global terms with total trade volume representing only around 1% of total world trade.

(ix) Southern Africa must develop new production and trade strategies to improve intra-African and regional trade by addressing governance including policy and institutional factors, which are claimed to be primarily responsible for causing poor management of the timber industry, leading to further deforestation and forest degradation. The main concerns have been lack of clear policies related to the timber industry, unresolved issues of equitable and secure timber rights, vested interests, policies focusing largely on economic growth generated by industrial development at the expense of sustainable timber production, weak and non-integrated sector policies impinging on the timber sector, policies addressing different environmental aspects often not coordinated, and weak and centralized regulatory systems.

(x) There is need for closer cooperation within and between RECs, such as Economic and Monetary Community of Central Africa (CEMAC), COMESA, East African Community (EAC), Economic Community of West African Countries (ECOWAS), Southern African Customs Union (SACU), SADC and West African economic and Monetary Union (WAEMU), for enhanced integration in timber production and trade in the continent and regionally, preferably under the trade areas Tripartite Tree Trade Area (TFTA) and Continental Free Trade Area (CFTA), which are designed to spur intra-regional trade and investment. This would also enable Africa to overcome limitations of too many small and fragmented markets, the huge differences within and between regions, the varied limited levels of trade integration within economic zones, the lack of economic diversification necessary to achieve the economies of scale necessary to compete internationally and in the continent.

(xi) National biofuels taskforces, being part of the regional SADC Biofuels Taskforce, must be revived or reinvigorated, through commitment of more resources at the national level and incorporation of a wider range of stakeholders in the process. This, plus the need for the development of a national biofuel policy, holds greater potential

for enhanced development of the biofuel industry in the region. Active taskforces are key to expediting the development of work plans agreed at SADC level, the national biofuel policies and cushioning against lack of continuity and implementation of national programmes that come with change of governments and frequent cabinet reshuffles, political interference and conflict of or vested interests, among other identified conflicts.

(xii) Participatory or community forestry approaches, well-established in the region, must be used to effectively track changes in the levels of fuelwood production and consumption. These approaches still remain strategically important for the implementation of SFM of fuelwood in the region. The adoption of these approaches will also help the region move away from the centralised control and management of forest resources. To this extent, the new approaches and relevant policies must be monitored, and countries must share experiences and learn from each other.

(xiii) In summary, the following short and long-term strategies have been recognised as important building blocks for tracking sustainable production and consumption of fuelwood for the region:

- Develop participatory fuelwood management and harvesting schemes/plans based on SFM;
- Secure forest tenure ("property rights"), a fundamental tenet for participatory management, by granting exclusive control and right to produce and market wood-based fuels;
- For marginal and/or degraded forest areas, involve the private sector and local communities, with potential to ameliorate the otherwise idle, unproductive and continually degrading areas;
    - Set up management plans for restoring and upscaling plantations and woodlands; develop and promote sustainable tree management, extraction and utilisation methods, with efficient and improved technologies and encourage use of alternative energy sources; train local bodies and professionals on SFM;
- Develop and promote silvicultural practices among private plantation owners in order to improve their standing stock and increase forestry productivity; and
- Develop mechanisms to improve regulation of the timber industry, through natural resources planning and monitoring, and enforcement of sovereign laws and regulations.

CHAPTER 1 INTRODUCTION

Biomass energy has remained the major source of cooking and heating in Sub-Saharan Africa (SSA). It is considered as the main driver of land use change and greenhouse gas emissions (GHG) in Africa due to unsustainable utilization that has resulted in deforestation and land degradation. This has been coupled with use and overreliance on fossil fuels that are major sources of GHG emissions causing global warming and resulting in climate change. The promotion of different forms of biofuels is therefore viewed as a measure of moving towards clean energy because of its carbon neutrality and the potential for climate change mitigation. Therefore, considerable interest to invest in large and small-scale biofuel enterprises has been created due to a number of advantages. Specifically, the emergence of first generation biofuel industry has created various opportunities such as: creation of jobs for the growing population, reduction of GHG emissions, opened new markets for agricultural crop surpluses, and generally enhanced economic development of the rural communities.

Cornfield in South Africa. Bio-ethanol is usually obtained from the conversion of carbon-based feedstock such as corn. Photo via Wikimedia Commons at https://en.wikipedia.org/wiki/Ethanol_fuel#/media/File:Cornfield_in_South_Africa2.jpg

However, some concern has been raised at the same time on trade-offs and risk it could generate. Specifically, the discourse is whether: agricultural sector could meet the biofuel demand without compromising food security; biofuels production could effectively mitigate climate change; increase in bio-fuel demand could result in increase in land use competition between food and fuel crops causing tenure insecurity among smallholder farmers; and how bio-fuel development can affect food security, energy needs and employment opportunities for the poor rural people.

Consequently, the bio-fuel industry is faced with some teething challenges such as: inadequate attention for sustainable raw material production; lack of processing facilities and where they are available, are in some cases underdeveloped; how to reconcile many, often conflicting policies and regulations from sectors linked to biofuel; limited blending with fossil fuels; and inadequate technical support to the rural communities who supply raw materials. In addition, the competition between food production, primary forest protection and land for commercial production of biofuels encouraged encroachment on uncultivated land, and especially woodlands and other forests leading to deforestation, loss of biodiversity and land degradation. There is a need to look at the various policies, regulations and institutional frameworks that support the development of biofuel industry, with a view of developing a harmonized approach to guide this industry.

A harmonised approach of major policies and their interdependence, though often resulting in dynamic and complex interrelationships emanating from such dependence in natural systems, is vital for the region in driving the biofuels industry. Efforts must therefore be made for the policies to be internally consistent with mechanisms to link and be in synch with other sectors (Kowero, 2003). Failure will lead to forest cover and its products decline in response to economic development, industrialization and urbanization (Agrawal *et al*, 2013). A recent feasibility study (Shonhiwa, 2015) has revealed the potential of biofuels exploitation in southern Africa in completely changing the living standards of people, producing clean energy, creating millions of jobs and making huge savings on foreign exchange, thereby boosting economic growth. The backdrop to the realisation of such potential rests with policies and related legislative frameworks in determining the direction of national and regional economic production and growth pathways for the biofuels sector, the focus of the current study.

1.1 STUDY OBJECTIVES

The main objective of the study was to generate knowledge that will improve African stakeholders' understanding on trends of forest cover changes and drivers of land use change in the context of food, fuel and fibre (3Fs), extractive industries and climate change. The information generated would strengthen countries and regional groupings on developing and implementing sound policies which address land use changes in the context

of the 3Fs and climate change. The resultant recommendations would enhance the role of African forestry and its contribution to adaptation to the adverse effects of climate change in various landscapes, and in ways that will improve livelihoods, sustain biodiversity and the quality of the environment. Further, the findings are expected to strengthen the capacity of Africa's forests to adapt to climate change and to contribute to mitigation efforts.

Specifically, the study sought to:

(i) Assess trends in forest cover change in selected hotspot areas of southern Africa;

(ii) Assess and document impact of extractive industries (timber, mining, charcoal making, etc.) on the 3Fs in the context of climate change;

(iii) Examine how the competition on biofuel production impact on food production, land security and biodiversity habitat;

(iv) Analyse the mechanisms supporting/incentivizing the production and commercialization of biofuels and the countries specific socio-economic contribution;

(v) Evaluate policies, legislations and other factors influencing land shifts between the 3Fs and blending of liquid biofuels and fossil fuels and implications on carbon in the context of climate change;

(vi) Assess fuelwood and charcoal policies and other practices that will make fuel wood and charcoal industry a viable business at national and sub-regional level;

(vii) Analyse strategies that will help track changes in the levels of production and consumption of fuelwood and charcoal; and

(viii) Provide appropriate key recommendations in relations to the above outlined tasks.

1.2 THE STRUCTURE OF THE REPORT

This report is presented in the context of policies and other issues related to the 3Fs in the context of climate change. It provides in Section 2 of the methodology chapter a brief outline of the region under study, the conceptual framework of the 3Fs and the approaches used in data collection and analysis. Section 3 discusses the results by outlining the trends in forest cover change, the impact of extractive industries on the 3Fs, how the competition on biofuels impacts on food production, land security and biodiversity habitat and the institutional arrangements for the development of biofuels in the region. Finally, Section 4 concludes the report by drawing on the lessons from the region and outlines key recommendations on policies and practices in the context of the 3Fs and climate change.

CHAPTER 2: METHODOLOGY

2.1 CONCEPTUAL FRAMEWORK OF 3FS WITHIN THE CONTEXT OF CLIMATE CHANGE

The unremitting concern of how to provide sufficient food, wood fibre and bioenergy for an ever-growing world population continues to draw sharply increasing attention and high political interest globally. This is particularly so in the face of limited land and water resources, complicated by continued climate change and its impacts. In this context, there appears to be wide agreement that food, wood fibre and bioenergy will compete intensively for the limited common resources of land and water well beyond 2030. The drive behind the global attention and interest therefore arises from a genuine desire to secure food security, energy security, national security, environmental security and political security; all signifying important value systems for man (Nilsson, 2007). As a consequence, these concerns have virtually defined the agenda for United Nations bodies, development partners, national governments, regional economic communities, among others with mandates related to agriculture, forestry, bioenergy and the environment, including climate change.

The overarching challenge therefore is how to produce the 3Fs under given land and water resource management systems, while protecting the natural ecosystems that sustain life on the planet. Central to this challenge is the issue of biofuels production, reputed as a solution to energy and climate change problems but whose effects are for example also known to increase food prices and negatively affect agriculture, land use and poverty (Scott, 2009). Thus the rapid growth in global demand for biofuels has given rise to concerns about competition between land for biofuels and for food production with FAO (2008), cautioning the likelihood of greater competition for access to land for the millions of people and posing a tremendous threat to their livelihoods. This conceptual framework appears at odds however with other studies that have shown that the southern African region for example has the potential to produce sufficient raw materials needed for biofuels without adversely affecting ecosystems, food security and traditional farming systems (SADC, 2005).

The potential for biofuels production in southern African countries is also based on the fact that crops used as feedstock for biofuels grow well in the region and in some cases perform better than in parts of the world that are major biofuel producers (E4tech, 2006; Malitz and Haywood, 2009). This is mainly because of the generally fertile soils, combined with conducive ecological and climatic conditions, suitable for the production of a wide range of biofuel feedstock. The soils include Kalahari sands that cover parts of Botswana, Zambia and Zimbabwe; sandy clay loams in parts of Malawi, Mozambique, Zambia and Zimbabwe; and vertisols or black cotton soils in southern Zimbabwe. On average, the region's rainfall ranges from 450 to 1 100 mm per annum and exhibits high intra and inter seasonal

variability (Esterhuizen, 2010; von Maltitz *et al.*, 2014; Barrow, 2014; du Preez, 2014). In fact, a situation analysis by Shumba *et al*. (2009) on Botswana, Malawi, Mozambique, Zambia and Zimbabwe show feedstocks commonly grown for biofuel production worldwide (Table 1) as not new and are either commonly cultivated for food (e.g. maize, sweet sorghum, groundnuts and sugarcane) or for commercial purposes (e.g. cotton, sunflower and castor beans). Additionally, sweet sorghum, sugarcane and jatropha were identified to be priority biofuel feedstocks for the region but with the latter two feedstocks being common to all the four study countries hence forming the subject of investigations and special focus in this study.

Other attributes analysed by Shumba *et al*. (2009) as favouring production in the southern Africa relate to the apparent non-competitiveness for land for food production and the already well-established sugarcane industry yielding molasses from the crop to produce bio-ethanol. Conceptually and in practice, the appeal for countries in the region to invest in biofuel production is its potential to reduce the dependence and spending on petroleum imports and in the longer term earn and save foreign currency. So far however, southern African producers have produced very little biofuel for either international or domestic markets. Other benefits include reduction of GHG emissions mainly from the transport sector and creation of employment and local markets for ethanol (Henley, 2014). Thus, in the case of small-scale production and processing of energy crops, production of biofuels would help to add value to locally produced crops by rural communities thereby enhancing their incomes (Woods, 2006). Proponents of this paradigm shift, suggest that southern African producers would therefore be well-positioned to supply the large and growing markets of developed economies as well as any new markets in emerging economies (Johnson and Matsika, 2006; Shumba *et al*., 2009).

Table 1: Crops commonly used as biofuel feedstock worldwide

Bio-fuel	Crop	
Bioethanol	Sugar crop	Starchy crop
	Sugar beet Sugarcane Sweet sorghum	Barley Cassava Maize Potatoes Rice Rye Wheat
Biodiesel	Oilseed crop	

Bio-fuel	Crop	
	Avocado pear	Macadamia
	Cashew	Oil palm
	Castor	Rape seed
	Cocoa	Sesame
	Coconut	Soya bean
	Cotton	Sunflower
	Groundnut	
	Jatropha	

Source: FAO (2008a)

Prospects for southern African producers are even higher when one considers the United Nations Development Programme (UNDP) report which states that the global production of biofuels doubled over the past five years and is predicted to double again in the next four years (UNDP, 2009). According to FAO (2007), demand for biofuels will grow by 170% in the next three years and will contribute 25% of the world energy needs in the next 15 to 20 years. Should these prospects be realised, it can be argued that producers, processors and investors involved in the biofuels industry and the region as a whole could have a future of great economic opportunities. This should also spur countries in the region to seriously enhance their efforts in the development of the industry.

Irrespective of such a positive prognosis on prospects for the biofuels industry for the southern African region, the agriculture, forestry and water sectors face particular challenges over the next decades due to increased global demand. For example, food production alone which is expected to grow by 70% until 2050, will put pressure on water, almost doubling its use, and bioenergy, which will in turn place further stress on production systems (Kuylenstierna, 2012). The key drivers of change will however remain more or less the same as in the past i.e. population growth, urbanization, changes in consumption patterns, climate change, economic growth etc. Expectedly, if these are not well managed, they will lead to conflicts and greater competition between different economic sectors, the 3Fs and also between regions and countries. Thus, in dealing with issues regarding the nexus 3Fs production or the conceptually-related water-food-energy security nexus (Kuylenstierna, 2012), it is imperative to study the interconnections between the key drivers of change and other societal changes at global, regional, national and local levels. Most fundamental though is the challenge that to date, the 3Fs issues have normally been approached with a sectoral perspective. The present study therefore attempts to move away from approaches focusing on sectoral trajectories by examining cross-sectoral policies and other issues related to the nexus food, fibre and fuel production. Such cross-

sectoral approaches have gained global recognition and attention as fundamentally important in addressing practices, policies and legal frameworks necessary to produce more food, wood fibre and bioenergy to supply the demands of a growing world population.

2.2 DATA COLLECTION AND ANALYTICAL APPROACH

This study investigates the extent to which policies and other related influencing factors in the southern African region and selected countries relate to the nexus 3Fs production in the context of climate change. In responding to the objectives of the study, additional focus is centred on how the governance instruments and frameworks mainstream or support the development of the nexus 3Fs in the relevant sectors of regional and national socio-economic development. This is expected to at the same time help to uncover the nature and level of commitment and the notable gaps in policy formulation and implementation surrounding the 3Fs.

While addressing issues of policies and their supportive legislative framework influencing the development of the 3Fs and related natural resources, the study firstly, examines the impact of the extractive industries related to the 3Fs and secondly, how the competition on biofuels impact on food production, land security and biodiversity habitat. For a more comprehensive analysis of such impacts as may be influenced by policies and legislative frameworks, the study triangulates information sourced from documents with that obtained from interviews and selected forest hotspots[1] per study country. This will help address some of the concerns, for example surrounding conversion of arable land for biofuels production at the expense of food production, or indeed the potential dangers of biofuel production on natural ecosystems. Thus, an examination is made on policies, legislations and other factors influencing land shifts between the 3Fs and blending of liquid biofuels and fossil fuels and implications on carbon in the context of climate change.

Since biofuels can offer great socio-economic opportunities for diversifying energy sources and livelihood systems through the development of the bioenergy industry, production and marketing of biofuel products, the study analyses the mechanisms supporting or incentivizing their production and commercialization. Specifically, an assessment is made on the fuelwood and charcoal policies and other practices where available that will make fuelwood and charcoal industries viable business ventures at national and sub-regional levels. In this regard, the study also analyses from source documents the corresponding strategies developed to track changes in the levels of production and consumption of fuelwood and charcoal.

[1] Forest hotspots being areas under anthropogenic pressures threatening their existence, through deforestation and forest degradation, their sustainability and ecosystems values.

Data collection involved both primary and secondary sources, mainly focusing on the key result areas, firstly by reviewing existing literature, regional and country reports, documents on policy and legislation, strategies and plans. Particular emphasis was placed on reviewing recent publications by governments, regional bodies and other organisations, such as Food and Agriculture Organization (FAO), UNDP, etc. Secondly, primary data collection involved country interviews with officials from relevant government agencies, stakeholders from the private sector, non-governmental organisations (NGOs) and national government agencies. The key result areas and corresponding types of data required per each result area are reflected in Appendix I. These key result areas were also used as a checklist for collection of relevant documents and for open-ended discussions with stakeholders, enabling more in-depth and exhaustive responses than would have been possible from a structured questionnaire. On average, the interviews across the southern Africa region were conducted over 3 days per country, with a total of 40 officials formally interviewed (Appendix II). Both quantitative and qualitative summaries and trends have been used to synthesise information on each key result area.

2.3 MAIN CHALLENGES OF DATA COLLECTION

The major difficulty in data collection across the countries under study was limitation of time, such that it was only possible to hold fewer interviews than scheduled in Appendix II. Delays in responding to applications or approving booked appointments for interviews by some government agencies, without which these were not permitted, led to cancellation of some interviews. Partly this was due to unwillingness to discuss and share documents that were regarded as either sensitive, such as those on mining, or in the process of formulation and development and therefore for internal use only. In some cases, even where interviews took place, relevant documents were not readily available and, for some of those who promised sending soft copies thereafter, these could not be sent even after repeated follow ups. Language barrier in the French-speaking Madagascar made it difficult to fully comprehend stakeholder responses and the various sourced documents, as these proved too expensive to translate.

Time constraints and long distances also made it difficult to conduct field visits, verify identified forest hotspots (Appendix III) and biofuel industry areas. In spite of much referred to developments related to the biofuels sector, data were scarce and therefore, no specific documents on biofuels policies and strategies were readily available. In spite of these limitations, the analysis of information from the available documents and interviews provided a fair overview of policies and other issues related to the nexus 3Fs production in the southern African region in the context of climate change.

CHAPTER 3: BACKGROUND INFORMATION

3.1 OVERVIEW OF THE SOUTHERN AFRICAN REGION

The regional economic community for the Southern African Region is the Southern African Development Community (SADC), established in 1992. SADC comprises 15 member states spanning over 554 919 km² with a diverse population of over 277 million. It has six land locked countries, five that have a total coastline and three that are Indian Ocean Island States. The main objectives of SADC are to: achieve development, peace, security and economic growth; alleviate poverty; enhance the standard and quality of life of the peoples of the Southern African region; support the socially disadvantaged through regional integration built on democratic principles and equitable and sustainable development (SADC, 2015).

The southern African region is experiencing significant economic growth as shown by a 5.1% Gross Domestic Product (GDP) growth average across the 15 member states (SADC Green Economy Strategy, 2015 cited in SADC, 2015). The services, industry and agriculture sectors of the economy contribute approximately 51%, 32%, and 17% of GDP, respectively. Projections indicate a steady but increasing growth rate of between 5 – 8% up to 2025. This positive projection is expected to be anchored on growth in agriculture and mining exports, with emphasis on increased manufacturing and primary industry activity and output, among other regional and national level initiatives (SADC, 2015).

However, there are critical constraints related to the 3Fs and also arising in what SADC (2015) terms as the water-energy-food nexus that have potential to derail or hinder the achievement of expected economic growth projections. These constraints are largely due to an increasing regional population averaging at 2.68% growth per year and characterized by a formidable rise in the middle income population (39% of total population) and rising urban class (by 3.39%) across the region. The corresponding consumption demands are higher than before, thus putting a strain on the natural resource base. Already this situation is exacerbated by high levels of poverty approximated at 45% of the population living under $1 per day (SADC, 2015).

The above constraints are compounded by global climate change, with natural and policy related impacts that have wide ranging effects across major and specific economic sectors including agriculture, energy, forestry, industry and trade, among others. In response to these climate related challenges, known to slow down GDP growth by -0.5 to -2% across the region (Hiernaux *et al*., 1999 cited in SADC, 2015), SADC to its credit developed the SADC Climate Change Strategy and Action Plan which aims to enhance the implementation

of other overarching regional policy and legislatives frameworks. These include the Regional Agriculture Policy; the Protocol on Environmental Management for Sustainable Development (2014) and the Protocol on Forestry, amongst others (SADC, 2015).

3.1.1 Climatic conditions and GDP

The climatic conditions of the southern Africa region vary from arid in the west through semi-arid and temperate areas in central zones to semi-arid in the east, with a few sub-humid areas in the central regions. Closer to the equator in Angola, Democratic Republic of Congo (DRC) and coastal Tanzania, the climate is largely humid (SADC, 2010). The region has been experiencing a warming trend over the past few decades. According to the IPCC (2014) cited in SADC(2015), temperatures in the region have risen by over 0.5°C over the last 100 years. The Indian Ocean has also warmed more than 1°C since 1950. During this period, the region has also experienced a downward trend in rainfall, characterized by below-normal rainfalls and frequent droughts (NCAR, 2005 cited in SADC, 2015).

The extreme climatic events that the region has been experiencing especially droughts are negatively impacting the inhabitants and economies of the southern Africa region. For instance, drought events that have occurred have resulted in significant decreases in agricultural production thereby making the agricultural sector highly vulnerable to climate change and accentuating the food insecurity situation in the region. The agriculture sector has deep interconnectedness with almost every other sector of the economy, hence the central role of agricultural development to the growth of both urban and rural economies including the rural non-farm sector and the transformation of the largely agrarian population to a more industrialised economy. Agriculture is therefore the major social and economic sector in the southern African region contributing between 4% and 27% of GDP and approximately 13% of overall export earnings (Davis, 2011 cited in SADC, 2015). About 70% of the region's population depends on agriculture for food, income and employment. Increasing rainfall variability, increased occurrence and severity of extreme events such as droughts and floods, prolonged mid-season dry spells and increasing mean annual temperatures have direct impacts on crop and livestock production in many ways. Overall, such climate change has affected agricultural production and access to food, nutrition and food security.

The member states need to grow their economies by taking into account the energy demand and consumption. The SADC energy sector comprises of the following subsectors; electricity, petroleum and gas, coal, wood and charcoal, nuclear energy, renewable energy and energy efficiency. The energy infrastructure development in the SADC region has been guided by the SADC instruments that include the Regional Infrastructure Development Master Plan (RIDMP) 2013-2017 and the Protocol on Energy (1996). The emphasis from these instruments is largely to harmonize national and regional policies and regulatory

frameworks, to cooperate in energy development and trading, exploiting the abundant energy resources in the region, and have coordinated planning and institutions.

3.1.2 Forest cover

The southern African region is home to almost 394 million hectares (ha) of forest and forest-like formations which is 41% of the region's land area. The region's forest resources constitute significant carbon sinks, though deforestation and land degradation are of special concern resulting in significant land use and land cover change. According to FAO, the annual deforestation rate in the SADC region amounted to 0.46% per year between 2005 and 2012, and since then the declining forest resources have further gone down by 0.6% per annum (SADC, 2015), resulting in high biomass losses and carbon emissions. Although the extent of forest cover (Fig. 1) and land use changes and the drivers of deforestation vary between countries, these changes are mainly driven by agricultural expansion, energy production and logging activities.

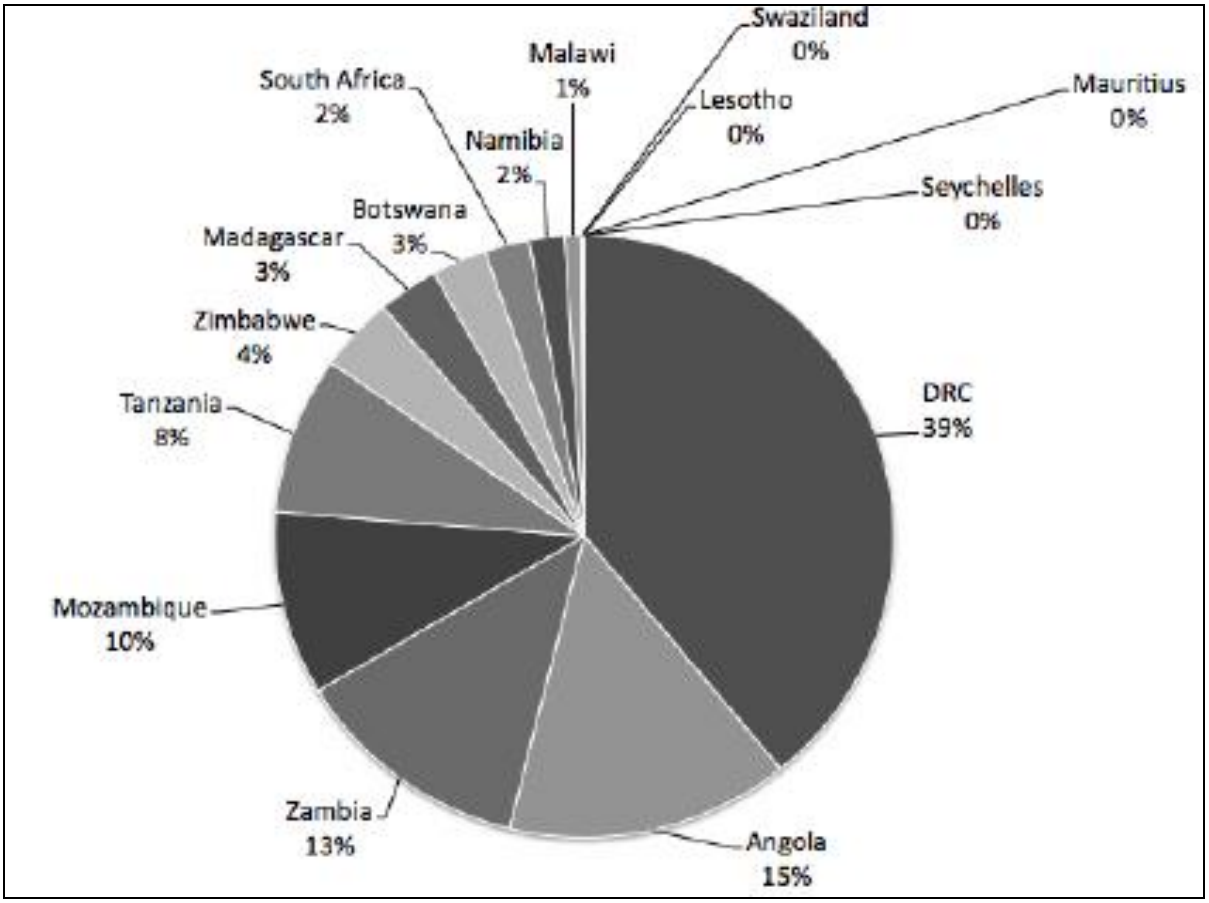


Figure 1: **Forest cover distribution for SADC countries (FAO, 2011)**

Most drivers of deforestation take place in the Miombo woodlands which represents one of the most extensive dryland forest vegetation types in Africa, stretching across seven countries in eastern, central and southern Africa from Zambia, Zimbabwe, Mozambique and Malawi to Angola and northwards into Tanzania and south-eastern DRC (Figure 2). Dominated by the legume family Caesalpiniaceae with the most prominent tree species being those of *Brachystegia* either alone or with *Julbernardia* and *Isoberlinia*, they occupy about 2.7 million square kilometres (White, 1983; FAO, 2000). Related woodlands in the region are the Kalahari Sands woodlands also dominated by the Ceasalpinioideae sub-family of the genera *Baikiea* and *Colophospermum* which cover much of northern Namibia, southern Angola and parts of Botswana, northern Zimbabwe and western Zambia (SADC, 2010). The Mopane woodlands dominated by *Colophospermum* mopane but also including a wide range of other species are found in pockets across the Miombo and Kalahari Sands regions, including Mozambique, southern Malawi, northern Namibia, southern Angola and large parts of Zimbabwe and Botswana (FAO, 2000). The greater Kalahari Sands woodlands region is also home to the drier Zambezian *Baikiaea* woodlands (including the species *Baikiaea plurijuga* or Zambezi teak) and the Kalahari *Acacia*/*Baikiaea* woodlands (Burgess *et al*., 2004).

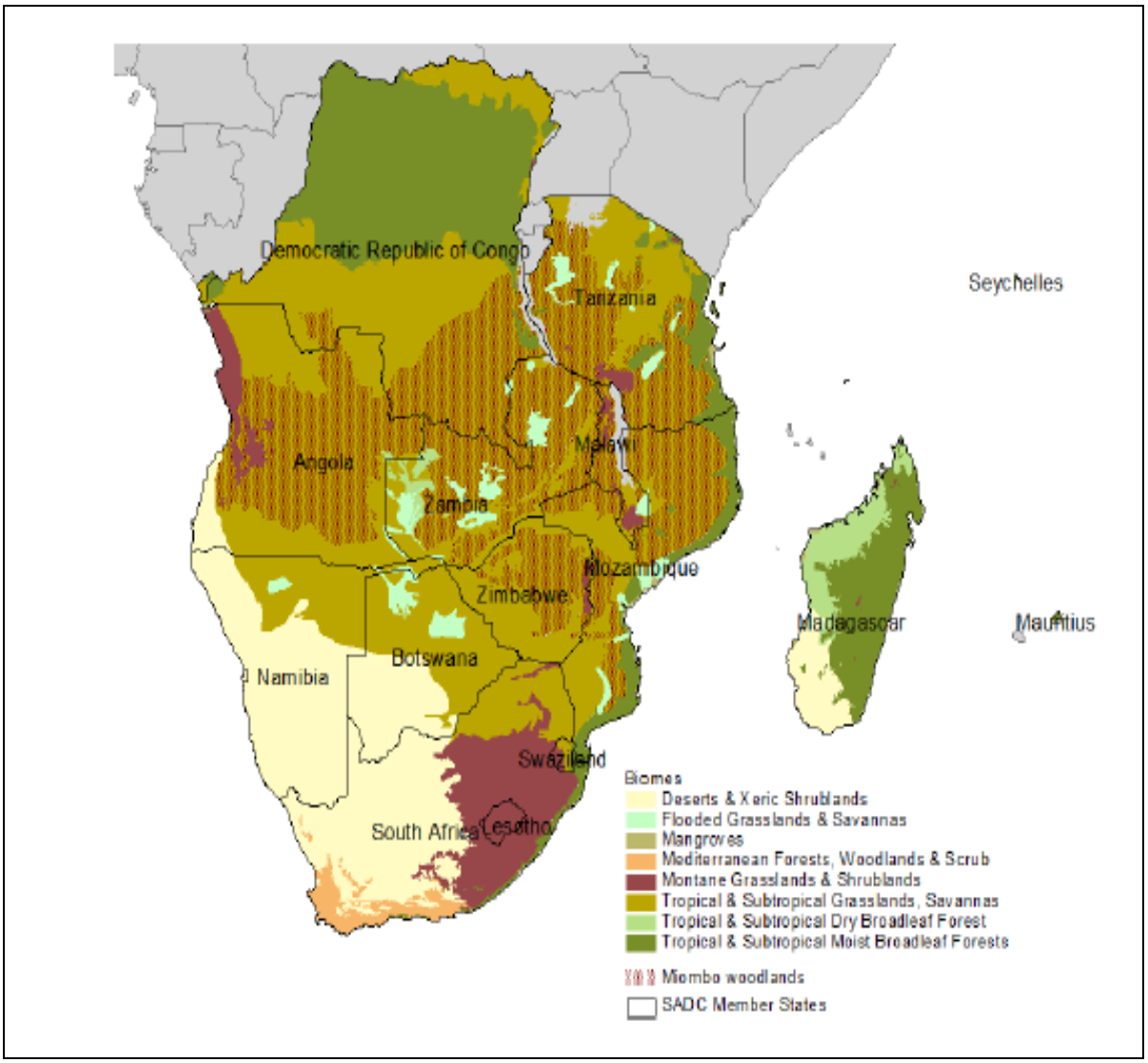


Figure 2: Distribution of major forest and woodland types in SADC region (Dewees *et al*., 2010)

In addition to these extensive woodland formations, the region is home to 'rich patch' forest vegetation, including riverine forests (or riparian woodlands) and at higher elevations, dry montane forests (Barrow, 2014). An example is the Afromontane archipelago forests represented by forest patches in the Eastern Arc Mountains of Tanzania, the Mulanje Massif in Malawi and the Drakensberg in South Africa (SADC, 2010). The region's coastline is a biologically rich and diverse mangrove ecoregion consisting of two large areas of mangroves in the deltas of the Zambezi in southern Mozambique and the Rufiji River in Tanzania. Smaller areas of mangroves are to be found along the coast in Angola, Madagascar, Mauritius, Seychelles and South Africa. The frequently unrelated plants comprising the mangrove formations in southern Africa involve nine different genera (*Xylocarpus* (Meliaceae), *Heritiera* (Sterculiaceae), *Sonneratia* (Sonneratiaceae),

Barringtonia (Lecythidaceae), *Bruguiera*, *Ceriops* and *Rhizophora* (Rhizophoraceae), *Lumnitzera* (Combretaceae) and *Avicennia* (Verbenaceae), all of them contributing in one way or another to the mangrove belts and hugely important from an ecological perspective serving as nurseries and foraging grounds for numerous marine creatures for coastal protection and aquaculture (Palgrave, 1983; Berjak *et al*., 1977; Beentje and Bandeira, 2007).

3.2 SPECIFIC PROFILES OF STUDY COUNTRIES

Zambia

Zambia with a total area of 752 614 km² had by 2014 a population of 15.72 million with the GDP estimated at US$ 27.07 billion growing at 5.6%. Zambia has experienced rapid economic growth over the last decade as Africa's second largest copper producer after the DRC. The economy has also relied heavily on agricultural production of corn, sorghum, rice, sugarcane, cassava (tapioca), among others. But its over-reliance on copper has made it vulnerable to falling commodity prices. Zambia also has one of the world's fastest growing populations with the UN projecting that its population of 15.72 million will triple by 2050. This has in recent years resulted in increasing demand for natural resources such as wood fuel (SADC, 2015).

Natural stand of Miombo woodland in Zambia. Photo © Forest Department of the Ministry of Lands, Natural Resources and Environmental Protection (MLNREP)

Traditional wood fuels such as charcoal and firewood dominate energy consumption in Zambia, the main sources being natural woodlands and agricultural lands. According to the Energy Services Delivery in Zambia Report 2004, the present consumption of wood fuel which exceeds the potential sustainable supply is a serious threat to the total forestry land cover currently estimated at 66% of the total land area (SADC, 2015). While wood fuel, petroleum and hydropower will continue to be the major energy sources in Zambia, 83.4% of its households still depend on wood resources for their cooking energy with only16.2% having access to electric energy for cooking. According to the Living Conditions Monitoring Survey of 2004, about 97.9% of the rural households solely depend on woody resources for their cooking energy while only

1.7% have access to electrical energy. In urban areas, 60.4% of the households depend on wood fuel most of which is charcoal (SADC, 2015).

Zimbabwe

Zimbabwe with a total area of 390 759 km², had by 2014 a population of 15.25 million, with an estimated GDP of US$ 13.83 billion, growing at 3.3%. The country has struggled to feed its own people due to severe droughts and the effects of a land reform programme which saw the seizure of white-owned farms redistributed to landless black Zimbabweans. This led to sharp falls in production and being cash-strapped and impoverished, Zimbabwe's economy faces severe challenges (SADC, 2015).

The country's forest resources cover approximately 66% of the total land area, 15% of which comprises protected areas, a sizable proportion of which has been encroached and converted to other land-uses, especially agriculture and rural settlements. About 40% (15.6 million ha) of total land area is covered by woodlands, indigenous moist forest and plantations of exotic commercial species. The forestry industry is dominated by a timber industry of exotic pine, followed by eucalypts covering an area of about 82,000 ha.

The smaller indigenous hardwood timber industry is based primarily on extraction of Zambezi teak and 'mukwa' mainly found on Kalahari sands in north western Zimbabwe, as well as pod mahogany, large false mopane and mountain mahogany. Fuelwood accounts for over 60% of the total energy supply whilst nearly 96% of the rural poor rely on fuelwood for cooking and heating, with a total national annual fuelwood consumption estimated at 8.54 million m^3 (GoZ, undated).

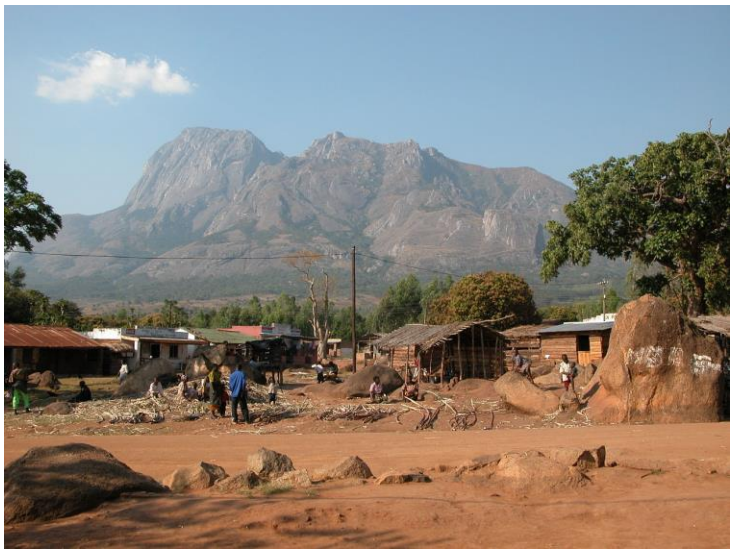
Firewood vendors with fire wood. Photo © Mujuru Lizzie/Zimbabwe

Malawi

Malawi with a total area of 118 484 km², had by 2014 a population of 16.7 million, with an estimated GDP of US$ 6.149 billion, growing at 5.7% (SADC, 2015). With an average of 103 inhabitants per km^2, increasing annually at 3.1%, the country's limited land area is under enormous environmental pressure from agricultural expansion, encroachment, overharvesting for fuelwood, charcoal production, tobacco curing and brick burning. The devastation is particularly marked in the densely populated southern region of the country where 50% of the country's people reside and only 20% of the country's forest land remains (Halle and Burgess, 2006).

The country's agricultural economy is heavily dependent on production of tobacco, sugar cane, cotton, tea, among others but the population suffers from chronic food insecurity, land degradation and pervasive poverty as the vast majority of the agricultural sector is made up of farmers cultivating small, rain-fed plots to grow food for consumption. A relatively small number of large commercial estates on irrigated land grow high-value crops for export. Malawi has potential to increase the amount of irrigated land and the Government has been investing in small-scale irrigation schemes to support expanded and increased production of food crops like rice (SADC, 2015). Globally, the country is an insignificant producer or consumer of minerals, with the sector providing a modest 1% of GDP through mining of coal, gemstones, uranium and a few other minerals (Alim, 2008; Chimwala, 2004).

About 36% of Malawi's total land area is classified as forest land, and 19% of the total land area is protected. Fuelwood accounts for over 89% of the total energy supply (split as 56% firewood and 33% charcoal), with electricity, paraffin and others such as residues/dung, coal, LPG accounting for 9%, 2% and less than 1%, respectively in the country's total energy mix (DoE, 2015). About 96% of rural households rely on forests and woodlands for fuelwood for cooking and heating (Bandyopadhyay *et al*., 2006; Mwase and Bjornstad, 2006).



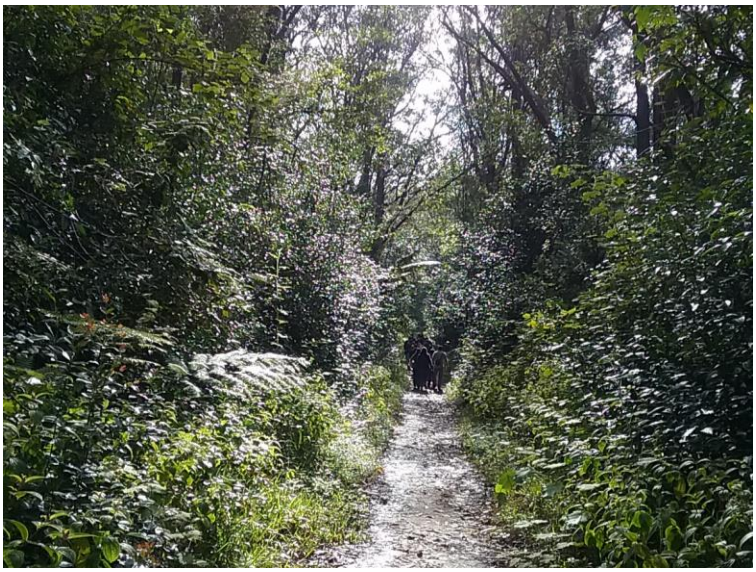
Mulanje Mountain Forest Reserve in Malawi. Photo via Wikimedia Commons at https://commons.wikimedia.org/wiki/File:Mulanje.jpg

Madagascar

Madagascar with a total area of 587 295 km², had by 2014 a population of 22 million growing approximately at 2.9%, with an estimated GDP of US$ 10.67 billion, growing at 3.3% (SADC, 2015). By 2015, the population had risen to above 24 million with 65% of total population being rural. The island is hugely endowed with natural resources including a variety of unprocessed agricultural and mineral resources such as graphite, chromites, coal, iron, cobalt, copper, nickel, bauxite, fish, and hydro-power, among many others. Madagascar has one of the world's largest reserves of ilmenite (titanium core) and currently provides half of the world's supply of sapphires discovered in the late 1990s. The agricultural economy is mainly based on coffee, sugar cane, cocoa, rice and many others, and is the world's principal supplier of vanilla, cloves and ylang-ylang. The economy of Madagascar is considered a market economy and is supported by its well-established agricultural industry and emerging tourism, textile and mining industries. In general, agriculture, including raffia, fishing and forestry is the mainstay of the economy. In spite of

its wealth of natural resources and a tourism industry driven by its unique environment, the country remains one of the world's poorest and heavily dependent on foreign aid (SADC, 2015).

Madagascar's energy balance shows that about 80% of its overall energy consumption is based on biomass (mainly firewood 68%, charcoal 10% and other biomass 2%), 17% on petrol (transport), 2% on electricity (hydropower and diesel power plants) and 1% on coal. The petroleum products are all imported though the country has oil in place but whose oilfields are not being exploited yet. Access to electricity remains low with about 20% of the total population having access to this form of modern energy. Only about 5% of the rural population currently have access to electricity which shows (a large discrepancy compared to the urban areas where more than 60% of the households have access to electricity. More than 80% of the population live in rural areas which signifies an untypically low level of urbanisation in the African context (Minten *et al*., 2010).



Andasibe National Park in Madagascar. Photo © Larwanou Mahamane/AFF

According to the existing law in Madagascar, all-natural forest is property of the state whether the land is owned by the state or not (World Bank, 2003). As such, fuelwood production and trade are regulated through a licensing system whose objectives are for conservation of the country's unique biodiversity (World Bank, 2004) by controlling forest resource exploitation within the limits of natural regeneration and for generation of revenue, especially for local- and district-level governments. In practice, however, this has been difficult to enforce as between 80% and 95% of the volume of charcoal for example is marketed without the required permits and sometimes only 3% of potential taxes are raised (Minten *et al*., 2010). Fuelwood is produced from a variety of ecosystems such as planted forests of eucalyptus and pines species in the central highlands, and natural forests in the lowlands (Meyers *et al*., 2006). Due to the significant variation in ecosystems, these natural forests range from dense, moist tropical forests in the east of the country to dry and spiny forests in the west and south-west (USAID, 2005). Continued fuelwood exploitation has resulted in land-use changes in favour of agriculture and pasture and pushed production further into the hinterland, further resulting in a range of ecosystems being used for charcoal production, with mangroves being the most prominent among them (Meyers *et al*., 2006).

CHAPTER 4: RESULTS AND DISCUSSION

4.1 TRENDS IN FOREST COVER CHANGE

This section briefly outlines the forest cover change in the countries under study and the related drivers of deforestation and forest degradation as summarised from observations made from a selected number of hotspots (Appendix III). These are outlined in Table 2 as drivers prevailing per country of study and used later as a basis for relating to the governing policies and other legal instruments or lack thereof. Table 2 reveals that deforestation is mainly from conversion of forestland to agriculture, a high dependence on wood as an energy source, unsustainable logging practices, infrastructure development, population growth and uncontrolled frequent, but very late fires. These drivers of forest cover change are consistent with those observed for southern African countries in general (e.g. Minde *et al.,* 2001, Gondo, 2013).

These causes of deforestation are linked to a number of issues, including policy and legislative frameworks. For example, individual interviews in Malawi related high population growth rate as a direct driver of deforestation to problems of market and policy failures. Other linked issues, also recorded as common to most countries in southern Africa (Minde *et al*, 2001), were to do with problems of land availability, poverty, drought, overstocking, infra-structural development, uncontrolled tree felling for fuelwood to cure tobacco in both the small and large-scale farming sectors, and opening up of new gardens and farming areas. The impact of such agricultural activities as reported by FAO (2000), results in more than 70 000 ha of forested land believed to be lost to agriculture annually in Zimbabwe, between 130 000 and 500 000 ha in Tanzania, between 200 000 and 300 000 ha in Zambia and on average 48 000 ha in Malawi. Regionally, forest fires, common to all the study countries (Table 2) are reported by FAO (2000) to have destroyed a total of 186 000 ha of woodland in the SADC region.

Table 2: Drivers of deforestation in study countries

Country	Direct drivers
Madagascar	• Conversion and expansion into cropland • Woodfuel exploitation • Mining • Timber logging, including illegal logging • Infrastructure development • Expansion of plantations • Forest fires

Malawi	• Conversion and expansion into cropland • Woodfuel exploitation • Timber logging, including illegal logging • Infrastructure development • Mining • Settlements & Forest Fires • High population growth
Zambia	• Conversion and expansion into cropland • Woodfuel exploitation • Timber logging, including illegal logging • Mining • Settlements & Forest Fires • High population growth
Zimbabwe	• Conversion and expansion into cropland • Woodfuel exploitation • Mining • Timber logging, including illegal logging • Forest fires

In an attempt to follow the trends in the rate of deforestation, this study examines the nature of deforestation in a specific hotspot area of miombo woodland in order to relate to the dynamics of forest change at a national scale. Reference is therefore made to one of the most recent site-specific information, provided by the SADC Secretariat, on a study conducted for testing the SADC Integrated Monitoring Systems for Reduction of Emissions from Deforestation and Forest Degradation (REDD+) in SADC (GIZ SADC Operations Report, 2014).

From this study, forest cover and land use changes for the reference years 1990, 2000 and 2010 (Appendix IVa) were derived in the trans-boundary areas between Malawi and Zambia. These areas of deforestation and classified land use changes on deforested areas were produced based on the EO Satellite data obtained from Landsat TM and RapidEye. The trans-boundary area straddles hotspot areas of miombo woodlands of Chimaliro Forest Reserve, Kasungu National Park, Nkhotakota Game Reserve and customary areas in between on the Malawi side and Luangwa National Park on the Zambian side. The histograms (Figs. 3, 4 and 5) illustrate the forest/non-forest areas between the different epochs, indicating that the forest loss is higher in the decade of 1990 to 2000 whereas it is

less during the decade of 2000 to 2010. However, there is evidence for an overall decline in the forest area in the 20 year period. The proportion of forest area decline appears similar in both countries.

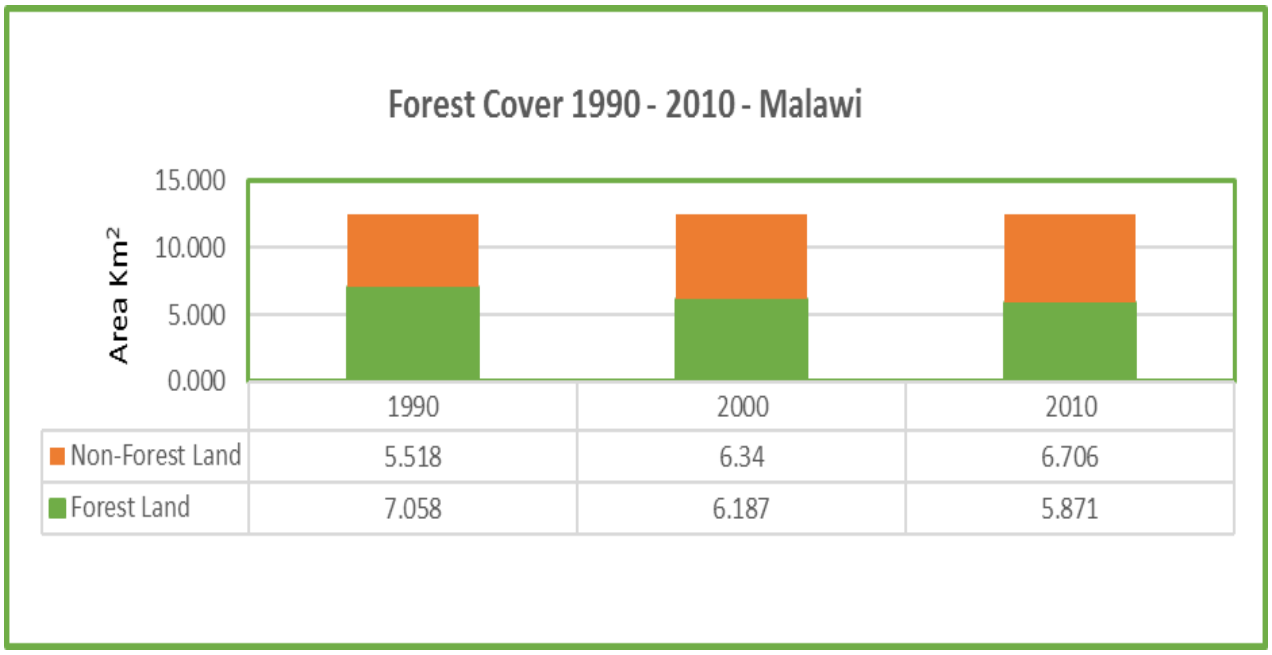


Figure 3: Comparison of forest and non-forest areas in 1990, 2000 and 2010 for the Malawian site

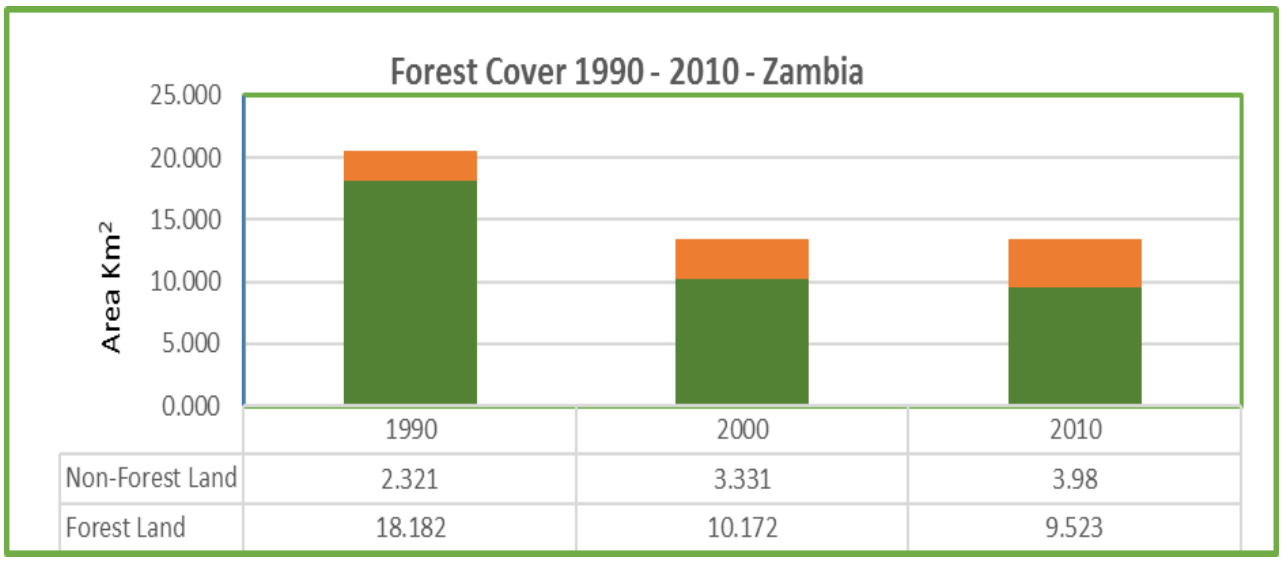


Figure 4: Comparison of forest and non-forest areas in 1990, 2000 and 2010 for the Zambian site

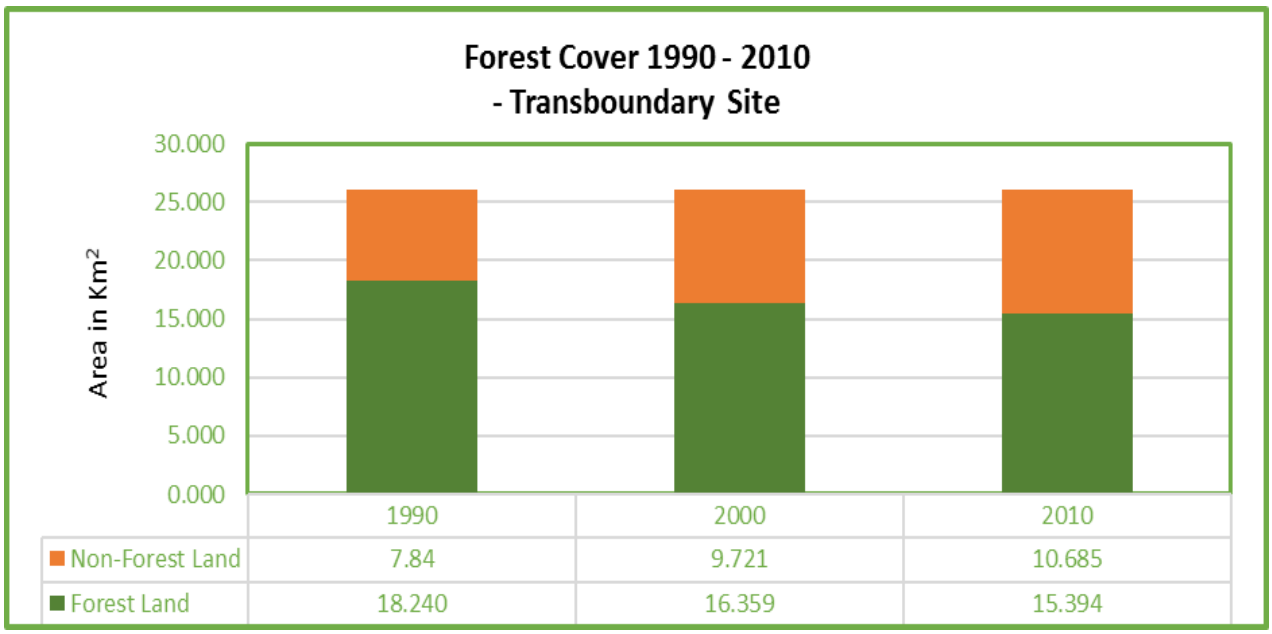


Figure 5: Comparison of forest and non-forest areas in 1990, 2000 and 2010 for the entire trans-boundary area in Malawi and Zambia

Specifically, the study showed that the gross deforestation rate for the whole trans-boundary site of 1 737.64 km^2 between 1990 and 2000, equated to a gross deforestation rate of 0.957%. Of the two countries, Malawi exhibited a higher deforestation rate of 1.1% compared to Zambia which had a rate of 0.85% within this period. For the period between 2000 and 2010, however, the gross deforestation area was 774.02 km^2 which is lower than what the overall trans-boundary site experienced between 1990 and 2000. This represented the gross annual deforestation rate of 0.5% which is almost half of what it was in the first decade. The main causes of deforestation across the trans-boundary site similar to those outlined in Table 2, were attributed to conversion of forest land to cropland, grassland, wetland, settlement areas and other land uses (Appendix IVb). Overall, the major cause of deforestation on both the Malawian and Zambian sides was conversion from forest land to crop land and accounted for 75% of the total change in the trans-boundary test site.

As observed in Figs 3, 4 and 5, both countries respectively showed a similar decline in the deforestation rates; very noticeable being the decline in the rate for the Malawi side of the trans-boundary from 1.11% to 0.37%. Though this is a site-specific finding, this observation appears to be consistent with the global forest resources assessment (FRA) (FAO, 2010). The latter showed that the rate of deforestation was slowing down, though the general decline in forest cover still remained alarmingly high. That as may be the case, it is however important to note from the FRA that the major trends in the extent of forests and changes in the rates of forest loss as well as the current state of productive and protective forests show disparities between regions across the globe. Thus, a similar scenario is observed for Africa where, out of its estimated 675 million ha of forest area, accounting for

about 17% of global forest area, 37%, 29%, 12% and 11% are variably located in the regions of Central Africa, Southern Africa, North Africa, East and West Africa respectively. Though there has been a reduction in the net forest loss in these regions, from 4.0 million ha per year in the decade 1990 – 2000 to 3.4 million ha per year during the period 2000 – 2010, the Southern African region had the highest net loss over the 20 years, although similar to the global trend, the rate has slowed in recent years (Table 3) (FAO, 2010).

Similarly, there is considerable variation in the rates of deforestation both within and between countries in the Southern African region (Table 3). Thus, FAO (2007) estimates show the rates of national deforestation across the region to vary between 0.2% in Angola and 1.7% in Zimbabwe; with those for the countries under study falling within this range, i.e., 0.9%, 0.9% and 1.5% for Malawi, Zambia and Zimbabwe respectively and 0.5% for Madagascar for the period between 2000 and 2005. In real terms, this means that the annual loss of woodlands varies between about 445 000 ha per annum in Tanzania and 33 000 ha in Malawi, which represents an already highly deforested landscape (UNEP, 2012). By these estimates, overall approximately 1.4 million ha of woodland were lost annually in the countries of Southern Africa, where miombo woodlands dominate (Campbell *et al.*, 2007). Viewed together, FAO's deforestation rates in Table 3 and Appendix IVc (for 2005 – 2010) reveal a region largely characterised by an ever-changing forest landscape, without a steady trajectory towards continued reduction of forest loss.

This is with the exception of Swaziland, which had an overall increased forest cover of 0.8% to 1.2% from 2005 through to 2012. Lesotho (0.46%), Mauritius (0.06%), Seychelles (0%) and South Africa (0%) are the other countries to have registered no deforestation in the 2005 – 2010 period, though there were minimal losses of forest cover for Mauritius (-0.6%) and South Africa (-0.1%) by end of 2012. In contrast, the overall trends in Table 3, for the same period, show that the deforestation rate more than doubled for Malawi and Zambia from 0.9 to 2.4% and 1.0% to 2.4% respectively, though the average increase was 0.46% for the region as a whole. These figures signify that regardless of disparities in rates of deforestation, there has been and continues to be on average a downward trend in forest cover nationally and regionally representing a continued loss of forest goods and services and thereby reduced opportunities for national and regional socio-economic development.

The continued losses of forest ecosystem services and decline in forest cover have drawn a key question of what actually drives deforestation and subsequently revealed a complex situation of multiple drivers and pressures. Often, there is rarely a single direct or indirect driver responsible for deforestation; most often multiple processes work simultaneously or sequentially, causing deforestation (Rademaekers *et al*., 2010). For all practical purposes, the drivers of deforestation are generally and broadly aggregated into direct or proximate causes (e.g. agricultural expansion, wood extraction, expansion of infrastructure) and underlying (indirect) driving forces (e.g. demographic, economic, technological, policy/institutional and cultural or socio-political factors). What is perhaps important to note

of the indirect drivers of deforestation is that they vary from country to country and even within a country, most certainly in southern Africa, and are often complex in nature. More poignant though is that due to the region's and Africa's diverse set of cultures, traditions, languages and political systems, a tendency is seen that in the majority of cases, deforestation is driven by the full interplay of institutional, demographic, economic, technological and cultural variables rather than by single-factor causation (Rademaekers *et al*., 2010).

To varying degrees, and as observed from information on the hotspots examined in Table 2, all these driver complexities have operated in the countries under study and in the region as a whole. Most of the documents sourced from the individual countries and the SADC Secretariat, as well as discussions with the various stakeholders (Appendix II), in agreement with past findings (Campbell *et al*., 2007; Chundama, 2009; Bond *et al*., 2010; Rademaekers *et al*., 2010; Vinya *et al*., 2011), bear evidence to the existence of markedly different and complex interplay of drivers of deforestation. However, these sources of evidence including from the hotspots in the study countries appear to converge on the fact that the main and most easily recognised drivers are the following proximate drivers:

- conversion of forested areas to agriculture (small and large scale) and settlements;
- extraction of fuelwood for household, urban and industrial purposes;
- commercial/illegal logging and timber extraction; and
- infrastructure development.

On a regional policy and legislative level, and in an attempt to address the drivers and reverse the impacts of deforestation, land disturbance and degradation, the southern African region developed the SADC Forest Protocol (SADC, 2002). The protocol promotes reforestation and afforestation programmes; promotes use and application of renewable energy technologies to reduce dependency on wood and charcoal; and promotes regional veld and forest fire prevention programmes. It also promotes and simplifies the implementation of the SADC REDD+ programme through education and public awareness programmes to enhance understanding of the value of forest ecosystems and issues of climate change.

The regional commitment towards addressing the underlying drivers of deforestation is equally shown by countries in the region through the development of related policies and legal frameworks at the national level. Though at various stages of development, a number of policies and acts of legislation related to forestry and energy across the four study countries have been introduced and are either in the process of formulation and development as is the case with Zimbabwe, where no formal policies on agriculture and forestry currently exist, or are being reviewed as in Madagascar. Zambia reviewed and

replaced its National Forestry Policy of 1998 with the new National Forestry Policy of 2014, though due to political changes, it was only launched in 2016.

Table 3: **Deforestation rates and changes in forest area in the SADC region in which miombo woodland is the dominant vegetation type**

Country	Total forest area (2005)	Total forest area (2012)	Annual rates of change					
			1990 – 2000		2000 – 2005		2005 – 2012	
			Area (1,000 ha)	% change	Area (1,000 ha)	% change	Area (1,000 ha)	% change
Angola	59,104		-125	-0.2	-125	-0.2		
Botswana		12,427					-111.843	-0.9
Lesotho		14					0	
Madagascar*	9,401	9,220	-997	-0.8	-261	-0.5	-181	-0.7
Malawi	3,402	2,562	-33	-0.9	-33	-0.9	-61.488	-2.4
Mauritius		16					-0.096	-0.6
Mozambique	19,262	30,601	-50	-0.3	-50	-0.3	-61.202	-0.2
Namibia		8,040					-72.36	-0.9
Republic of South Africa (RSA)		8,917					-8.917	-0.1
Swaziland		523					6.276	1.2
Tanzania	35,257	38,811	-412	-1.0	-412	-1.1	-77.622	-0.2
Zambia	42,452	31,246	-445	-0.9	-445	-1.0	-749.904	-2.4
Zimbabwe	17,540	19,040	-313	-1.5	-313	-1.7	-285.6	-1.5
SADC		152,195					-1422.76	-0.46

Source: FAO (2007); *Approximated from NOE (2013); SADC (2015)

Overall however, interviews across the study countries have revealed that these policies invariably have been characterized by widespread failure in terms of implementation and enforcement thus indirectly contributing to deforestation and subsequent forest decline. A number of reasons were identified as contributing to this scenario, among which are lack of political will, political interference, vested interests and corruption, agricultural subsidies, low levels of government support and therefore weak implementing institutions, independent and uncoordinated operations of sectors and therefore lack of synergies, overriding policies such as those on mining over forestry, and inconsistencies in both policy and legislation. Though there was no hard evidence provided to establish the linkages between these largely underlying causes of deforestation, the fact that they were consistently mentioned lends some weight to their importance and impact.

4.2 IMPACTS OF EXTRACTIVE INDUSTRIES ON THE 3FS AND CLIMATE CHANGE

4.2.1 Mining

Stakeholder interviews and information from sourced documents reveal that mining and minerals exploitation in the study countries remain a strong extractive industry, with contributions to the GDP ranging from 20% in Malawi to 90% in Zambia. The enabling policy and institutional frameworks vary considerably among the countries, with Zambia having the most comprehensive supportive framework embedded in the following:

- the Revised Sixth National Development Plan (2013 – 2016), and the following which are under review:
- the 1995 Mining Policy and legislation;
- the Mines and Minerals Development Act of 2008;
- the Petroleum (Exploration and Production) Act of 2008; and
- the Explosives Act of 1974.

The policy and legal instruments governing the sector are currently in various forms of review but all designed to facilitating diversification and to building a robust, growing mining and minerals sector. For such a dynamic and growing sector, establishing linkages between this extractive industry and deforestation, emissions and climate change is critical in understanding the impacts of extractive industries. The need to establish such linkages was strongly expressed by different stakeholders interviewed during the study, mainly due to their perceived impacts as summarised in Table 4. Unfortunately, as also observed by others (Vinya *et. al*., 2011) and for reasons given under Section 2.3, there appears to be no

specific studies providing empirical data available to demonstrate and validate these perceived interlinkages. What is clear though is that there is a clear hierarchy of legislation which puts mining as top priority over and above other sectors like forestry and is well-embedded in the policy and legislative framework. Additionally, this reveals that the degree of coordination and harmonization of policies and legislation across the two interlinked sectors is very poor. Thus, in the case of Zambia, pursuant to the Mines and Minerals Development Act of 2008, all rights of ownership in prospecting and disposing of minerals are vested in the President "notwithstanding any right, title or interest which any person may possess in or over the soil in, on or under which minerals are found."

Table 4: **Impact of mining and minerals sector in the study countries**

Country	Associated Causes	Impacts
Zambia	• 1989-2002 structural adjustment programme (substantial cuts to mining workforce) • Economic downturn in global copper prices (massive retrenchment of mine workers).	• Clearing of large tracts of natural forests for: Provision of agriculture land and settlement of laid off miners • Loss of forest resources, contributing to climate change
Zimbabwe	• Shallow deposits, open cast mining • Blasting	• Clearing of vast areas of forests and woodlands for: Cultivation and settlement • Reduced wood and fuelwood availability • Dust and gaseous emissions, polluting the atmosphere
Madagascar	• Expansion of mining	• Conversion of forests to agriculture • Decimation and fragmentations of forests, clearing of 600 ha of primary forest and 360 million m^3 of wood, attributed to 29 years of mining operations for Ambatovy (nickel-cobalt) (UNEP, 2012)
Malawi	• Creation of new mines and expansion, e.g.	• Clearing of large tracts of forests for mining and operations, cultivation of

	Kayelekera Uranium mine • Opening up of shallow mines	crops • Reduced availability of wood and fuelwood • Dumping of waste products and destruction of natural vegetation • General increase of prices of food and other commodities due to increased demand • Environmental pollution to water systems • Social unrest, instability of family institutions, and health issues • Displacement of community members (NCA, Action Aid & CEPA, 2014)

Similarly, the outdated and now revised 1981 Mines and Minerals Act of Malawi, rested the ownership of the resources on the Life President on behalf of Malawians. The new bill, yet to be tabled in Parliament, rests the ownership of the resources on the state on behalf of the people of Malawi. The implication is that with the current law formulated during the oppressive one party regime, powerful politicians have had an enabling environment to manipulate mining deals for their personal gains. Whether or not such policy and legislative restrictions are the reason why studies have not yet been commissioned to directly link mining to deforestation, emissions and climate change, is an issue which this study was not able to establish, but all the same worth investigating.

4.2.2 Charcoal and firewood

Charcoal, often linked with firewood and collectively referred to as wood fuel – is a major source of cooking and heating energy for most urban households in SSA.[2] As it constitutes a primary extractive industry and one of the major drivers of deforestation and forest degradation (Table 2), this study seeks to establish the importance of its production, commercialization and consumption. In addition, the study attempts to determine the extent and impact of this extractive industry on the environment and climate change in these countries and the southern African region as a whole.

[2] See FAO (2010) which states that between 50% and 80% households in sub-Saharan Africa depend on charcoal

A review of work done in the countries in the region (Chidumayo, 1997; Kambewa *et al*., 2007; GRZ, 2010; Yaron *et al*, 2011; Nyembe, 2011; Gumbo *et al*., 2013; among many others) and information from stakeholder interviews show that across the southern African region, production is mostly done in rural areas especially forested areas close to urban centres but largely consumed in urban to peri-urban areas. For example in Zambia, Malawi and Madagascar, 85 %, 45%, and 90% of the predominantly poor urban to peri-urban households respectively rely exclusively on this energy source (Chidumayo, 1997; GRZ, 2010; WWF News, 2010; Yaron *et al*, 2011; Nyembe, 2011). This is not surprising considering that across all these countries, charcoal is relatively cheaper when compared with electricity and petroleum-based fuels, which works well for the low income urban to peri-urban households (Hibajene and Kaweme, 1993; Kambewa *et al*., 2007). In addition, the impetus for continued overreliance and growth in urban demand for this form of energy, leading to its increased production, commercialisation and consumption, appear solidly founded in its contribution to national economies by providing household incomes, tax revenues and employment along its value chain. As stated by Trossero (2002), this is true not only for the southern African region but also for most developing countries.

The trend analysis conducted on a selected number of countries (Table 5), though not based on exact corresponding years, affirms these positive impacts of this extractive industry, with significant national contributions to trade across countries of between US$ 31.1 to US$ 650 million per year and to GDP of between 2.3 - 3.7 % between 2007 and 2010, with that for southern Africa being 3.0% for 2008. As a growing trade, IEA (2010) projects the trade for Africa to grow to US$ 12 billion per year by 2030, up from US$8 billion in 2007 (World Bank, 2014).

The annual employment figures for the years 2007-2011 range from over 50,000 in Zambia to 200,000 in Malawi, with an average of 500,000 engaged in southern Africa in 2008. Again, IEA projects employment in the industry to grow to 12 million people by 2030, up from over 7 million people engaged in 2007 (World Bank, 2014). Thus it is estimated for example that in Malawi, 92,800 people owe their livelihoods to charcoal and though the charcoal industry is operating unlicensed, its estimated value of roughly about US$ 41.3 million is slightly less than the value of Malawi's tea industry (Kambewa *et al.,* 2007). For Tanzania, the US$ 650 million per year contribution of the charcoal industry to its economy in 2009 is said to have been 5.8 times the combined value of coffee and tea production, apart from the generating incomes for several hundred thousands of households in both urban and rural areas (World Bank, 2009a). This lucrative industry is said to earn individual charcoal producers numbering over 50,000 engaged on full-time basis in Zambia anywhere between US$ 3,000 and US$ 9,000 per year (Kalinda *et al*., 2008). The studies done by the World Bank Energy Sector Management Assistance Programme (ESMAP) even suggest that promoting charcoal can create more jobs than any other forms of energy (Kakuzi, 2003).

According to the United Nations Environmental Programme (UNEP), the socio-economic factors examined in Table 5 plus the ever-increasing population growth in Africa, imply that the demand for charcoal is likely to double or triple by 2050 (Deccan Herald, 2016). A similar observation by Gumbo *et al*. (2013) based on an analysis of current economic conditions as well as rapid urbanization in Zambia, showed that the trend in charcoal production and consumption is on the rise. The analysis on the charcoal and firewood production and consumption (Table 6) reinforces this development and gives evidence of a defining future of continued dependence on charcoal as a major form of energy in southern Africa. As depicted in Table 6, already annual charcoal consumption in Malawi more than quadrupled between 1998 and 2011 (Yaron *et al*, 2011), while that of Madagascar (1980-1996) and Zambia (1969 – 2010) increased five-fold and more than three-fold respectively. Clearly, given the levels of consumption in Table 6, the high population growth and increased urbanisation can only lead to a greater demand for charcoal, implying increased production and consumption.

Table 5: Charcoal and firewood contribution to GDP, trade and employment in selected southern African countries with regional comparisons

Country	Year	GDP %	Trade	Employment	Source
Malawi	2007	3.0			Yaron *et al*., 2011
Malawi	2008	3.0			
Malawi	2010	3.5			Zulu, 2010
Zambia	2007	3.7			Yaron *et al*., 2011
Tanzania	2007	2.3			Yaron *et al*., 2011
Southern Africa	2008	3.0			Von Maltitz, 2013
Malawi	2007		$ 40 mil./yr		Kambewa *et al.*, 2007
Malawi	2011		$ 42 mil./yr		Yaron *et al*, 2011
Zambia	2008		$ 3,000-9,000/yr/individ		Kalinda *et al*.,

			ual		2008
Tanzania	2009		$ 650 mil./yr		World Bank, 2009
Mozambique	2008		$ 200 mil./yr		Kwaschik, 2008
Namibia	1991		$ 13.1 mil./yr		Hailwa, 1999
RSA	1991		$ 100 mil./yr		DWAF, 1997
Africa	2007		$ 8 bil./yr		World Bank, 2014
Africa	2030		$ 12 bil./yr projection		IEA, 2010
SSA	2007		>$ 8 bil./yr		Neufeldt *et al*., 2015
Zambia	2008			>50,000	Kalinda *et al*., 2008
Malawi	2007			92,800	Kambewa *et al*., 2007
Malawi	2009			200,000	MARGE, 2009a
Southern Africa	2008			500,000	Von Maltitz, 2013
SSA	2007			>7 mi.	Neufeldt *et al*., 2015
Africa	2007			>7 mi.	World Bank, 2014
Africa	2030			12 mi. projection	IEA, 2010

The high population growth stands at 4.0%, 4.7%, 5.3% and 2.5% for Mozambique, Tanzania, Malawi and Zambia respectively while increased urbanisation is at 4.0%, 4.7%, 5.3% and 2.5% for Mozambique, Tanzania, Malawi and Zambia, respectively (May-Tobin, 2011; Gumbo *et al*., 2013). This continued increasing trend, together with its projections, draws a most pertinent question that cannot be ignored and that is how to strategically meet the current and future energy needs of a growing population.

Table 6: Charcoal and firewood production and consumption in selected southern African countries with regional comparisons

Year	Million tonnes			Country/ Region	Source
	Used	Yield	Annual consumption		
1969	1.179	0.340	0.330	Zambia	Gumbo *et al*., 2013; Malambo and Syampungani, 2008.
1980	2.196	0.505	0.490		
1990	3.070	0.760	0.685		
2000	4.056	0.933	0.905		
2010	5.428	1.248	1.211		
1969-2010 (31 yrs)	Grew by 460%	Grew by 367%	Grew by 367%		
1998-2011(12 yrs)			Grew by >400%	Malawi	Yaron *et al*, 2011
1980-1996 (16 yrs)			Grew by 500%	Mozambique	Yaron *et al*, 2011
2000-2010 (10 yrs)			Grew by 3%	Africa-wide	Iiayama, 2013
2007*	231,177			Malawi	Kambewa *et al*., 2007
2009*	304,690			Malawi	MARGE, 2009a; GoM, 2010
2013*	364,950			Malawi	Hecht and Kasulo, 2013

*National level studies estimated charcoal consumption in Malawi with similar order of magnitude but requiring updating with follow-up studies; considering change in average urban population growth of 4.2% between 2010 and 2015 (UN Data, 2015)

It must be noted however that the increased trends of charcoal production, as driven by the factors discussed above, bear strong resemblance to and mirror global and regional trends (see Fig. 6). This brings into sharp focus the need to strategically find solutions to meet the growing demand in a coordinated manner across national, regional and global scales. In addition, the apparent steeper gradient (Fig, 6B) suggests that production and consumption of charcoal could increase considerably and at a faster rate in regions of Africa than for the other regions of the world (Fig. 6A). Such trends, as projected for Africa by Arnold *et al*. (2006), could lead to doubling of charcoal consumption by 2030 against only a 24% increase for firewood. Consistent with the magnitude of increased annual consumption levels depicted in Table 6 (i.e., for Malawi, Mozambique and Zambia against Africa-wide) and taking into account the prediction by Arnold *et al*. (2006), southern Africa may well be the region in Africa with the most serious challenge on how to meet such growing consumption levels from its existing resources.

In a review of work done in Africa, which suggests that most charcoal production on the continent constitutes unsustainable forest mining of existing natural woodland stocks, Zulu and Richardson (2013) conclude that most SSA countries are ill prepared for this challenge, which essentially undermines charcoal's poverty-reduction potential and its other important attributes in Table 5. An assortment of reasons for this state of affairs should serve as a benchmark for the much-needed reforms in SSA to overcome the unsustainable over-exploitation. As summarised by Zulu and Richardson (2013) from the work by the World Bank (2009b), Zulu (2010) and others, such defining reasons include weak, misguided, neglected, underdeveloped, disjointed, overly prohibitive, existent woodfuel contradictory or non-policies and laws, combined with poor enforcement and regulatory capacity.

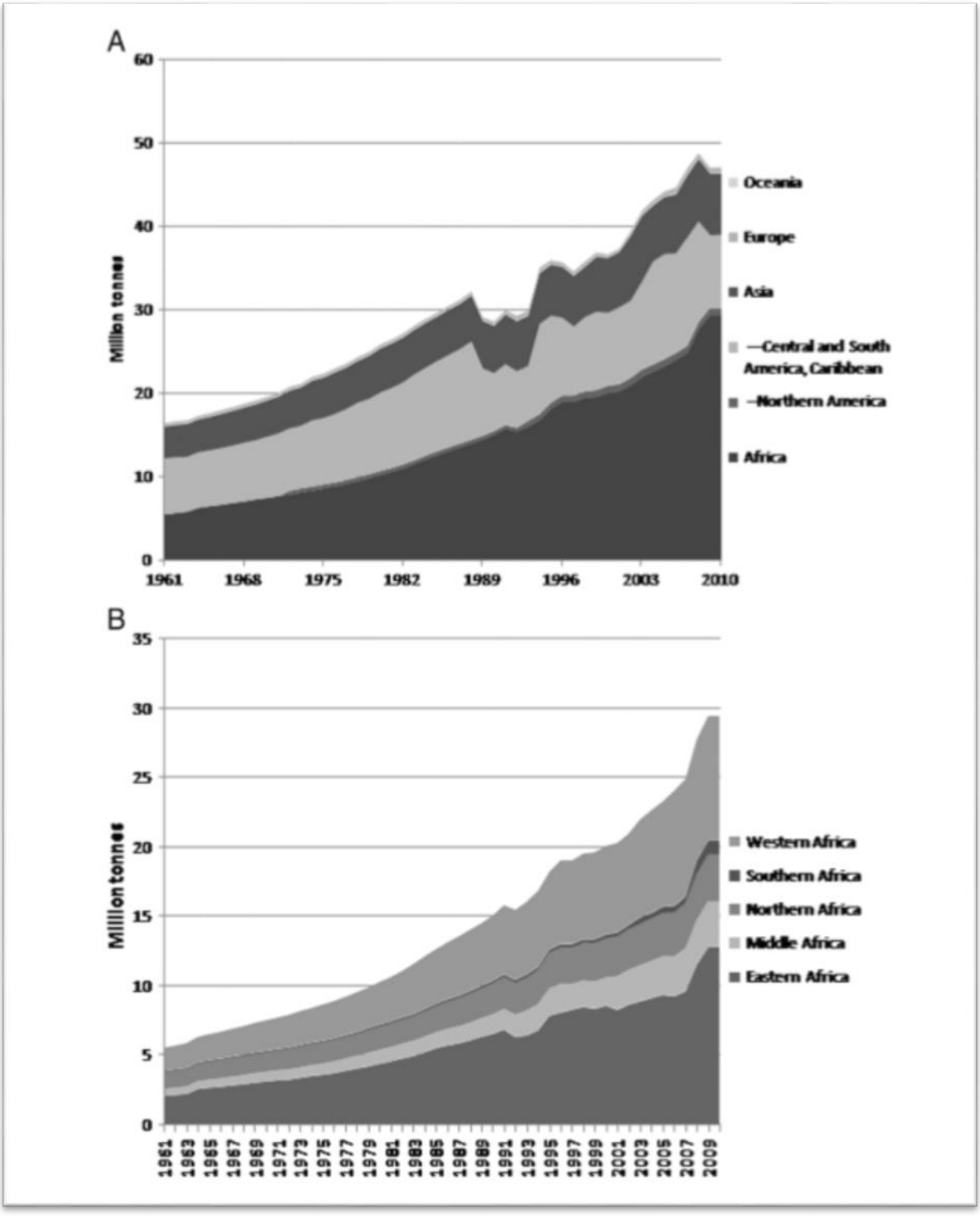


Figure 6: A. Charcoal production by region of the world: 1961 – 2010 (millions of tonnes). B. Charcoal production by region of Africa: 1961 – 2010 (millions of tonnes).

Source: FAOstat.http://faostat.fao.org/site/626/default.aspx#ancor.

These have raised concerns which as stated by Gumbo *et al*. (2013), have become more urgent than ever before as the charcoal industry is increasingly becoming more lucrative and in some cases operating under limited legal and policy framework. To this extent, introducing major policy and institutional changes, integrating woodfuel issues in national economic and poverty reduction policies which has hitherto been inadequate and tokenistic (Zulu and Richardson, 2013), away from the status quo under current deforestation rates deserves serious attention. Without these interventions, it is difficult to see how the growing demand could be met, while at the same time contributing to and sustaining livelihoods, poverty reduction, national economies, employment, environmental sustainability, and mitigating and adapting to climate change.

Several studies conducted in the southern African region attribute environmental degradation, negative health and climate change impacts as partly due to charcoal production, mainly arising from its contribution to deforestation and forest degradation and to utilisation of incomplete combustion technologies during production, which releases harmful GHG emissions into the atmosphere (e.g., Chidumayo, 2010; LTS International, 2015a). How to minimise these negative attributes is of primary concern. Two types of earth kilns, i.e., the pit kiln and the surface earth-mound kiln have predominantly been in use in the region for a long time (Foley, 1986; Pereira *et al*., 2001; Siedel, 2008). For these traditional kilns, only 35% of the wood carbon is fixed in charcoal and the rest is released into the atmosphere as smoke and non-condensed gases such as carbon dioxide, carbon monoxide and methane (CO_2, CO, CH_4) and others (Hibajene and Kalumiana, 2003; Chidumayo, 2010. Though there are currently no wood conversion efficiencies established as a standard (Mwitwa and Makano, 2012), the traditional technique of charcoal production, the earth kiln in Zambia, Malawi, Madagascar and Mozambique is estimated to have a conversion efficiency of 12%, 20%, 10-12% and 14-20%, respectively (Makungwa, 1997; Openshaw, 1997; Pereira *et al*., 2001; Mugo and Ong, 2006; ETFRN News, 2014). It is precisely due to these low rates of conversion efficiencies that more wood than is necessary is used to produce the same amount of charcoal. Thus, for example in Zambia, an estimated 5 to 10 tons of wood is needed to produce a ton of charcoal, irrespective of the area cleared and effects on the ecosystem (Chidumayo, 2010).

However, a number of improved, modified forms of surface earth kilns have also been in use in the region. These include those with ventilation channels (e.g. the Casamance kiln), including the stand-alone brick kilns and metal kilns that offer better carbonisation resulting in higher yield (about 25-30% conversion efficiency) and better-quality charcoal (World Bank, 2009b). The drawback is that since these mainly stationary kilns are costly and only best suited for industrial charcoal production, they are not suitable for the majority small-scale mobile charcoal producers most of whom operate illegally. As a result, the improved kilns are too few and their adoption rate too slow to create any major difference to the overall loss of wood to help reduce the negative impacts of deforestation and forest

degradation (Hibajene and Kalumiana, 2003; Sepp, 2008; Handavu *et al*., 2011). The reasons for this are mainly found in the informal and often illegal nature of charcoal production such that without secure and long-term access to wood resources, investments by producers for more efficient conversion methods are likely to be limited (World Bank, 2009b; World Future Council, 2015). To this extent, this study reiterates the need for major policy and institutional reforms that would integrate wood fuel issues in national policies in order to formalise and encourage investments in charcoal production.

Drawing on investigations from Malawi and the region (e.g. Yaron *et. al*., 2010; Chittock, 2010; Chidumayo and Gumbo, 2013), LTS International (2015a) affirms the general consensus that charcoal production, together with agricultural expansion and firewood collection are the most important proximate drivers of deforestation and forest degradation. Illustrated in Figure 7, such a consensus may however be viewed as a simplification of the complexities of interactions and causations often underlying the agents of deforestation and forest degradation (LTS International, 2015b), the limitations of categorising them when operating as a sequence of events in the same area (Ahrends *et al*., 2010); and the causal chain to the underlying or root causes. For example, LTS International (2015a) states that deforestation from charcoal production is commonly associated with agricultural expansion, though it is difficult to distinguish the causality of one over the other; in other words, is the agricultural expansion happening as a result of degraded forest from charcoal production, or vice versa?

Thus, generalising about drivers is difficult in large part because reliable and specific data does not exist, causes are closely intertwined and their separation in impossible. Further, LTS International (2015a) questions if the axe swings to create space for an agricultural field, or fuel for a kiln? Whether or not charcoal production leads to deforestation or forest degradation is thus highly variable and subject to disagreements with MARGE (2009b), distinguishing deforestation as resulting in a permanent land use change (e.g. forest to agriculture or forest to settlement) from charcoal harvesting which leaves woodlands to recover or during the practice of shifting cultivation. Regardless of the diverging views, there ought to be spatial and temporal considerations to the complexities and influence of the drivers – both proximate and underlying - most notably the conversion of forests for agricultural production, pastoralism, and logging (Zulu, 2010; Chidumayo and Gumbo, 2013; Mwampamba *et al*., 2013). An important distinction should also be made that at a small spatial scale there is the possibility of charcoal production resulting in forest clearance, but on a larger scale it mostly results in forest degradation due to the selective harvesting of wood for charcoal (Chidumayo and Gumbo, 2013).

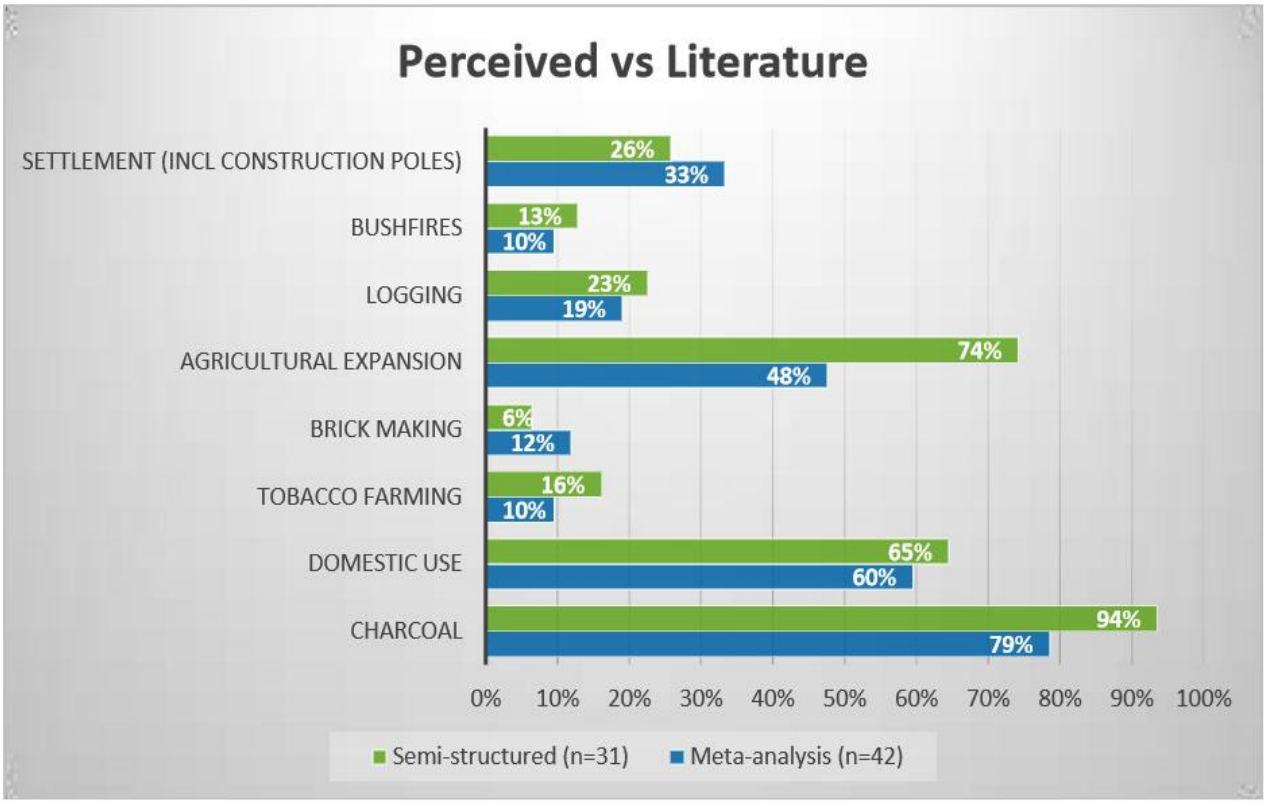


Figure 7: The relative importance of proximate drivers to deforestation and forest degradation in Malawi as derived from semi-structured interviews and meta-analysis of literature

Source: LTS International (2015a)

Greenhouse gas emissions and deforestation rates

In view of the difficulties highlighted above, it is equally difficult to distinguish the exact proportion of GHG emissions due to each of the proximate drivers. However, it can generally be assumed that the bulk of emissions comes from charcoal production, fuelwood collection and agricultural expansion as these have been identified as the most important drivers of deforestation and forest degradation, with the meta-analysis isolating the former two as being of relatively greater importance (Figure 7). Based on this reasoning, the deforestation rates given earlier in Table 3 can be assumed to be largely due to these three most important drivers and more so due to the charcoal and firewood exploitation. This is postulated with the view to determine the extent to which fuelwood production may be linked to GHG emissions and subsequently to environmental degradation and attendant climate change problems. Similarly by using this approach, the study sought to verify claims made during the interviews in the study countries that though electricity remains the main and preferred alternative to charcoal, particularly in urban and peri-urban areas, this form of

energy appears not to be readily available, unreliable and unaffordable to the majority of people. To verify and ascertain these trends of possible interrelationships, this study analysed data sets on average annual GHG emissions (kt CO_2 equiv.) (Appendix V), end user electricity tariff increases (US cents/kWh) (Appendix VI) and deforestation rates (Figure 8).

In referring to Figure 8, it is important to note firstly that the total GHG emission values (kt of CO_2 equivalent) (Appendix V) refer to CO_2 totals mainly from forestry and all anthropogenic CH_4 sources, nitrous oxide (N_2O) sources and F-gases hydrofluorocarbons, perfluorocarbons and Sulphur hexafluoride (HFCs, PFCs and SF6), excluding those from short-cycle agricultural waste and savannah. Secondly, there is over the 42 year period of assessment and considerable variation in values between years, within and between countries, largely owing to differences in emission sources and anthropogenic activities (Table 7). Clearly however, these results show that Zambia, Madagascar, Zimbabwe and Malawi consistently achieved in descending order higher total values in 2012, higher maximum and minimum values (though of varying years) over this period which correspondingly signify greater emission activities in that same order.

Table 7: **Total greenhouse gas emissions (kt of CO_2 equivalent) per country over a 42-year period.**

Country	Total (2012)	42 year period (1970 - 2012)			
		Minimum	Year of minimum	Maximum	Year of maximum
Zambia	320,254	132,224	1988	448,614	1998
Madagascar	117,933	31,700	1971	163,798	2003
Zimbabwe	72,058	21,231	1972	76,392	1998
Malawi	21,632	4,125	1971	21,632	2012

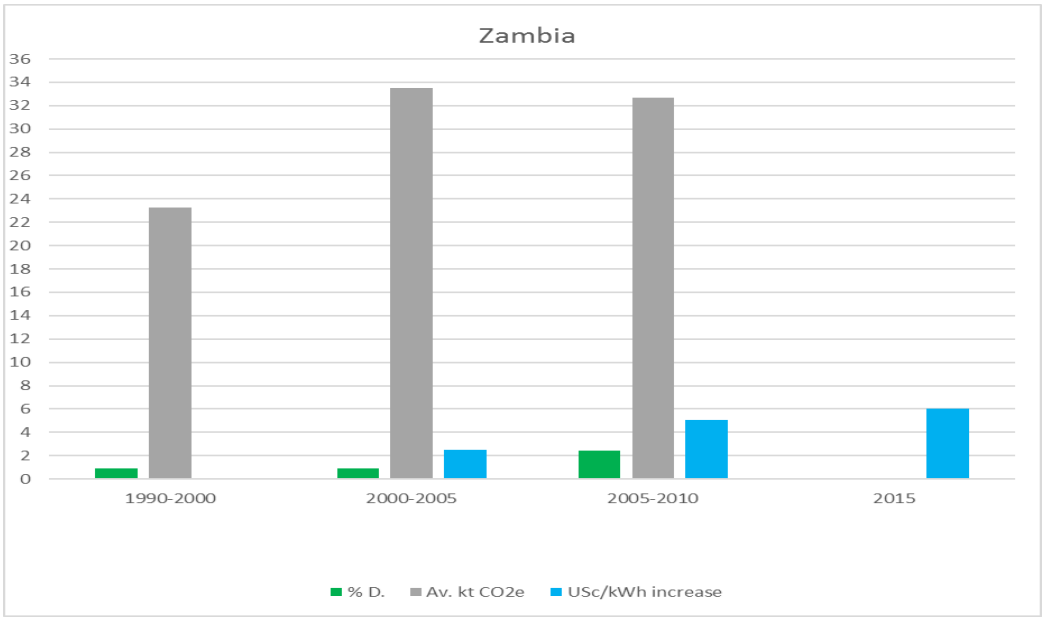
When average total GHG emissions are juxtaposed against deforestation rates for countries with the same miombo woodland vegetation namely Malawi, Zambia and Zimbabwe, a general incremental relationship is apparent (Figure 8), though differences in magnitude of the relationships between countries is obvious. In the case of Zambia, differences in emissions for the periods 2000-2005 and 2005-2010 is not substantial though slightly lower in the latter period. Overall, Figure 8 shows that the levels of GHG emissions for the entire 1990 – 2010 period, generally increased with increased deforestation rates. Being a major factor of deforestation rate, these results consistent with other findings (e.g. Malambo and Syampungani, 2008; Chidumayo, 2010; Chidumayo and Gumbo, 2013; LTS International,

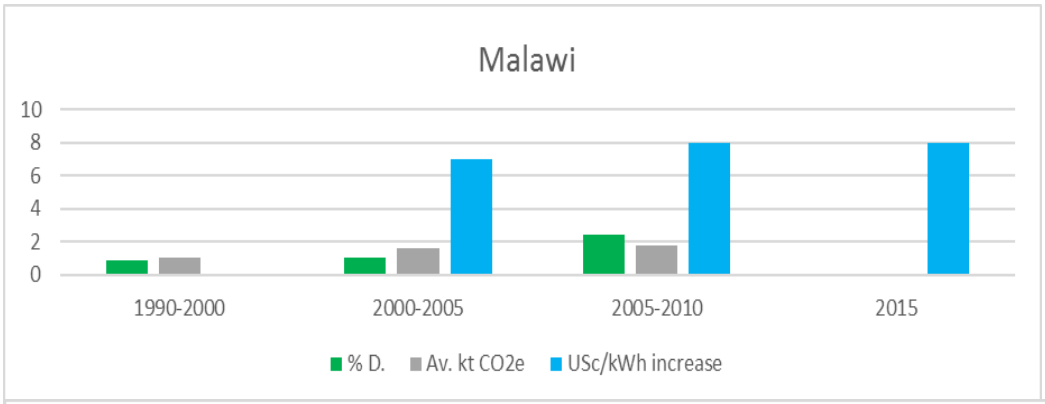
2015a), affirm that charcoal and firewood production contribute to the release of harmful GHG into the atmosphere. Though the southern African region contributes about 2.29% to the overall global GHG emissions (Table 8), with relatively lower percentage contributions from individual countries (between 0.01- 0.18%; except for South Africa with 1.46%), the unsustainable production and consumption levels of charcoal and firewood are therefore of major concern.

Electricity supply and deforestation rates

The concerns related to unsustainable charcoal and fuelwood production and use which were thoroughly discussed during country interviews with various stakeholders centred on the need to find suitable and sustainable alternatives. This gave the perception that the countries were advancing various approaches towards “energy transition” or migration from use of biomass fuels to modern cleaner forms within a country’s energy mix, such as petroleum-based alternatives (liquid petroleum gas (LPG) and kerosene) and electricity. A review of the two SADC instruments for energy infrastructure development, the RIDMP (2013-2017) and the Protocal on Energy (1996) shows the strategic energy subsectors to include electricity, petroleum and gas, coal, wood and charcoal, nuclear energy, renewable energy and energy efficiency (SADC, 2015). Of these, electricity was considered the main alternative by the stakeholders although it was regarded as not readily accessible or unaffordable to most people, particularly the poor urban and peri-urban households. Individual country data sets in the region, representing end user electricity tariff increase values (US cents/kWh) (Appendix VI) were used to try and understand and verify the issues of accessibility and affordability.

The accessibility and affordability of electricity appear to be generally a function of the energy mix available to a country. Thus, the electricity generation mix has an effect on the average end user electricity tariffs in a country (Sikwanda, 2016). Fig. 9 illustrates this very well for the southern African region where the average end user electricity tariffs ranged from USc 3.10/kWh to USc 16.04/kWh in 2015. The United Republic of Tanzania had the highest tariff at USc 16.04/kWh followed by Namibia at USc 15.00/kWh, while Angola had the lowest tariffs at USc 3.10/kWh followed by Zambia at USc 6.00/kWh (RERA, 2015).





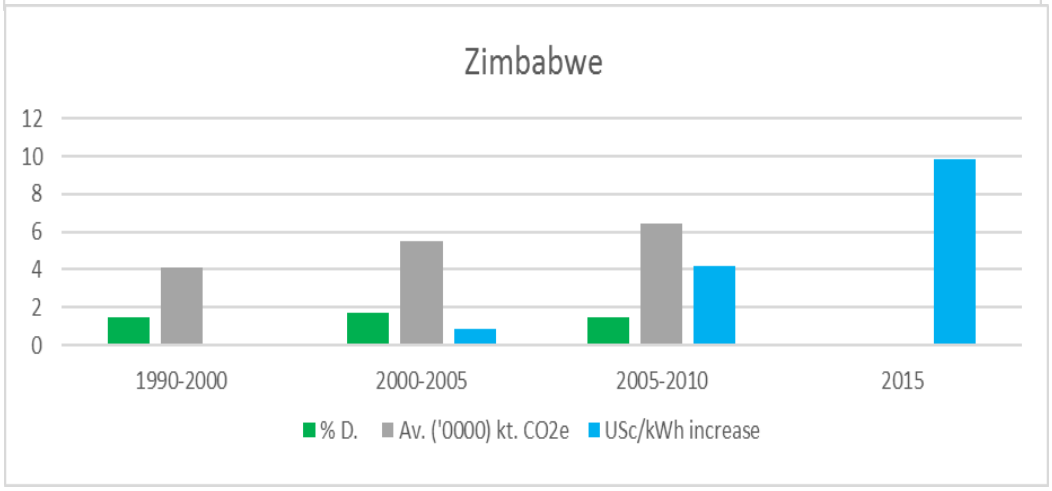


Figure 8: Deforestation rates (%) and related average annual GHG emissions (kt CO_2 equiv., '0000) and end user electricity tariff increases (US cents/kWh)

Invariably, the different end user electricity tariffs depicted in Figure 9 will have varying implications on the levels of exploitation of other available forms of energy, with charcoal and firewood being of central concern for southern Africa. For this reason, and in order to verify the claims made during interviews of the high cost of electricity which was said to force people to continually depend on charcoal and firewood, one part of Figure 8 traces the end user electricity tariff increases from 2000 to 2015. By using the country data sets for Malawi, Zambia and Zimbabwe representing end user electricity tariff values (US cents/kWh) (Appendix VI), Figure 8 clearly shows an upward surge in electricity tariffs, which is consistent with increased rates of deforestation and emissions. This confirms that as long as electricity tariffs keep increasing beyond affordability of most people, continued and unsustainable production and consumption of wood fuels would be the order of the day into the foreseeable future. Given the trends in Figure 8, observed for the entire 15 year period, there appears to be no plausible reason to believe that this scenario will change in the short to medium term, unless there are drastic measures taken to confront the challenges.

Table 8: Southern Africa total and per cent of greenhouse gas emissions communicated as Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in their national communications

Party	Emissions (Gg CO_2 equivalent)	Percentage	Year
Angola	61,611	0.17	2005
Botswana	6,140	0.02	2000
Democratic Republic of Congo (DRC)	22,434	0.06	2010
Lesotho	3,513	0.01	2000
Madagascar	29,344	0.08	2000
Malawi	24,959	0.07	2000
Mauritius	4,758	0.01	2006
Mozambique	8,224	0.02	1994
Namibia	5,180	0.01	2010
RSA	544,314	1.46	2010
Swaziland	18,658	0.05	2000
United Republic of Tanzania	40,506	0.11	1990

Zambia	14,405	0.04	2000
Zimbabwe	68,541	0.18	2000
Total	**(Global) 37,168,339**	**(Southern Africa) 2.29**	

Note: National communications through GHG inventory reports, biennial reports or biennial update reports, as of 12 December 2015. Since the communicated amounts are for different years, they do not represent an accurate estimate of current global GHG emissions and therefore the amounts provided in this table are only relative.

Source: UNFCCC (2016).

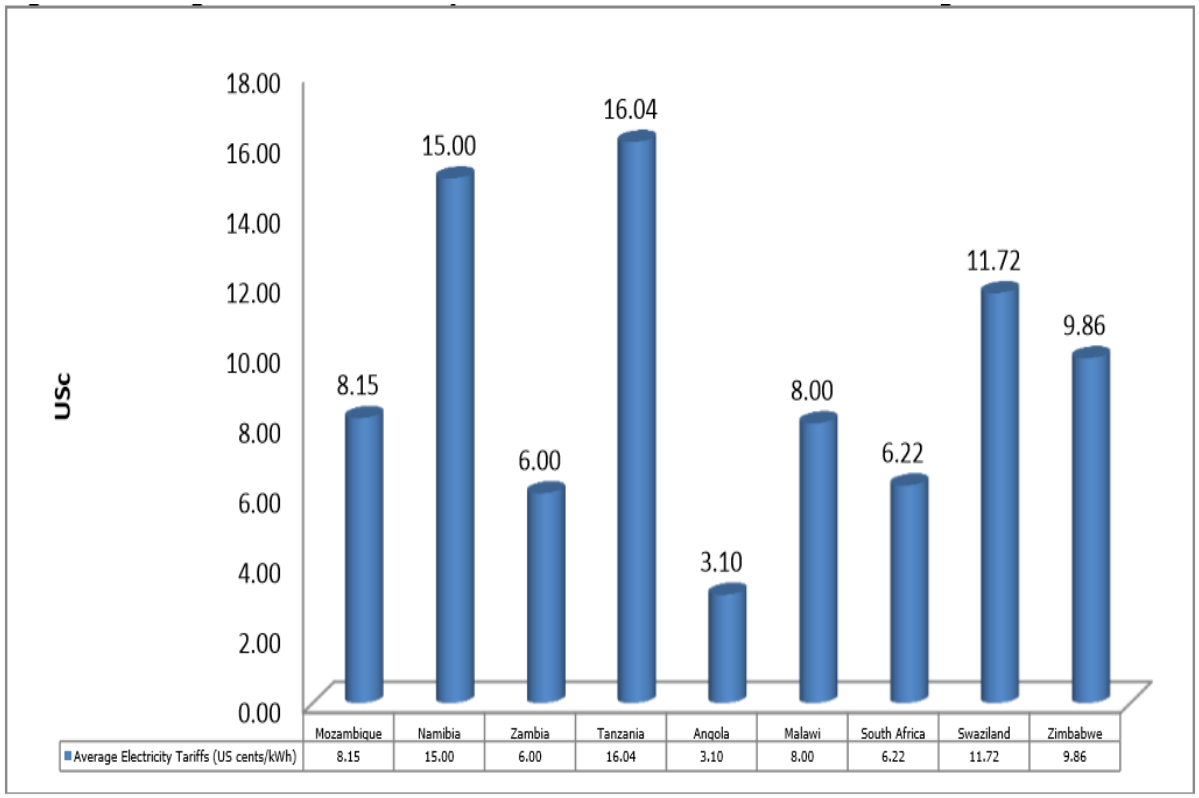


Figure 9: Average end user electricity tariffs in selected SADC countries – August 2015

Source: RERA (2015)

The need for measures to resolve the challenges however calls for judicious consideration of a number of strategic issues in a region dominated by hydroelectricity generation, regarded as one of the cheapest forms of power production compared to thermal and coal. One of the challenges that must be addressed by most SADC countries today is the need to balance the act between access and affordability. According to Cecila and Maria (2001), most policy makers are caught in between balancing the act between cost reflectivity and affordability. A cost-reflective tariff ensures recovery of all the allowable costs of each regulated and licensed activity within the generation, transmission, distribution and supply value chain and also ensures a reasonable rate of return on investment. As such, regulators must balance the financial sustainability of the sector against the well-being of various segments of society, especially the poor residential customers in determining tariffs. Affordability in the context of electrification and use of electricity means whether or not households can afford to actually use electricity once they are connected to the grid. The cost of electricity for consumers is assessed in relation to household incomes, purchasing power (opportunity costs of other goods) and relative cost of electricity compared with other commodities. In a region where half of the population is estimated to live below the international poverty line of US $ 1 per day[3], regulators face a stiff challenge in the SADC region as they must decide the tariff rate that would be affordable and yet not making the utility worse off (Sikwanda, 2016).

The above plus public resistance towards any migration to cost reflective tariffs (i.e., by increasing tariffs); insufficient investment and aging infrastructure and difficulties in collection of revenues for the electricity delivered are among the other challenges that underpin the problems of accessibility and affordability in Southern Africa (Sebbowa, 2010; World Bank, 2015; Sikwanda, 2016). Needless to say, these challenges whose impact results in use of non-reflective tariffs by countries in the region, except for Namibia and Tanzania (reported to have already achieved cost reflective tariffs), manifest themselves in power deficits leading to load shedding, higher system losses and failure to attract investment (Sikwanda, 2016). As a region, SADC has enormous responsibility to curtail political interference in the operations of power utilities, an important factor in transitioning electricity supply industries towards cost reflective tariffs; in itself a call by SADC which has largely remained unheeded since 2008 (SARDC, 2010). However, in respect of the trends of applicable tariffs (Figures 9 and 10) and future transitioned cost-reflective tariffs, these being unaffordable for the majority of people in the southern African region, neither help reduce nor replace the present and future dependence on firewood and charcoal as a major source of energy. The factors noted in this study, in concert with observations made by others (e.g. IEA, 2010; Zulu and Richardson, 2013), such as continuing growth in urban charcoal demand with rapid population growth, urbanization and increasing costs of

[3] http://www.sadc.int/themes/social-human-development/

alternative fuels, including electricity, affirms the dominance of charcoal in the energy mix of the region in the foreseeable future. This study therefore draws the attention of SADC and countries in southern Africa to the fact that neither the unrelenting charcoal dilemma nor the electricity woes will disappear any time soon. It becomes imperative therefore as also noted by Zulu and Richardson (2013), that it is now time to proactively reform charcoal policies and laws to promote regulated, sustainable production and trading of charcoal.

The Policy framework

To examine the status of existing policy frameworks, approaches and reforms related to charcoal as an important part of the energy mix in the region, this study analysed information sourced from documents (e.g., Kojwang, 2000; World Bank, 2009b; Dieckmann and Muduva, 2010; Dewees *et al*., 2010; Mwalimu, 2016) and stakeholder interviews, as summarised in Appendix VII. There is certainly wide diversity between the selected countries in the way charcoal is addressed and envisioned in terms of policy and institutional frameworks, reforms and approaches. The charcoal sectors in Malawi, Tanzania and Zambia have largely been centralised and restrictive, with intermittent banning of charcoal; only to see these relaxed after a spate of riots and protests. Such restrictions have proved counterproductive as they have only succeeded in pushing the illegal activities underground, led to loss of government revenue, uncontrolled environmental degradation and to increased levels of unsustainable production.

In consideration of these factors, subsequent reviews of policy frameworks and approaches in Madagascar (originating from the 1997 Forestry Policy) have however led to the adoption of innovative, decentralised sustainable charcoal production systems, where secure tenure rights are granted to individuals and households through an afforestation/reforestation programme. Though not operating at quite a similar scale nationally, similar sustainable forest management (SFM) methodologies are being undertaken through a decentralised process involving groups of communities in Tanzania to sustainably produce charcoal. Tanzania recognises that there ought to be an integrated policy framework involving many sectors including energy, forestry, agriculture, transport, and even health, in order to have a comprehensive approach that takes care of the entire charcoal value chain. The development of such a national charcoal policy would necessarily include inter-agency and cross-sector coordination through a policy dialogue that would in the end avoid the complexity that lies with different responsibilities by different sectors along the same value chain.

Recent policy reviews in Malawi and Zambia which culminated in the new 2016 Malawi National Forestry Policy and the 2014 Zambia National Forestry Policy, have demonstrated major shifts in approaches towards addressing fuelwood challenges. The major policy strides largely being a moving away from the centralised and restrictive policy frameworks of former policies and giving prominence to charcoal and firewood as major forms of

energy. Appropriately, both policies have embraced the building blocks for sustainable charcoal production by first recognising the inadequate supply of electricity, LPG and/or biogas; the increasing firewood and charcoal demand, exacerbating already high deforestation rates; and the impact of unsustainable production on environment, socio-economy and climate change. For effective implementation of the new policies through a decentralized approach, all stakeholders are to engage in sustainable charcoal production through SFM, by designing and putting in place production areas; charcoal tracking systems to ensure sustainable harvest and production; and to regulate exports and promote efficient charcoal production methods, among other strategies (Appendix VII). Overall, there are striking similarities between Malawi and Zambia in the new policy and legal frameworks governing charcoal production and it would be important to monitor the extent to which the two countries share experiences and learn from each other going forward.

Likewise, apart from Madagascar and South Africa (for commercial charcoal production), Namibia has valuable experiences worth sharing with the countries in the region on developing a sound charcoal policy framework. The Namibia framework exemplifies an innovative approach of how a by-product of cleared invader bush can be used to develop a thriving charcoal industry which has grown significantly in the 2001–2010 period to become an important economic sector. The policy created in terms of formal and international trade in wood energy is regarded as one of the most organised commercial charcoal producers in southern Africa, with the industry exporting charcoal to markets in Germany, United Kingdom, South Africa, apart from satisfying local consumption (Kojwang, 2000; Dieckmann and Muduva, 2010). By exporting charcoal to South Africa, a neighbouring and fellow SADC member country, Namibia demonstrates the existence of and potential for cross-border trade in charcoal between countries in southern Africa. Already, the commercial charcoal produced by companies in South Africa formally finds its way in supermarkets in the region, though largely meant for the middle-income clientele. The region also appears to have well established informal and formal cross-border trade and routes across countries such as Malawi, Mozambique, Zambia, Zimbabwe and Tanzania (Minde and Nakhumwa, 1998; Gumbo *et al*., 2013).

Since this regional informal trade has been growing for decades due to its increasing high-demand across countries in southern Africa, one important lesson for the region to learn is that charcoal has increasingly become such an important socio-economic commodity that it can no longer remain in the informal sector. Sooner than later, existing trade agreements between countries mainly under the coordination of SADC and Common Market for Eastern and Southern Africa (COMESA) will have to become part of the normal formal trade between countries. Otherwise, the absence of the shift from informal to formal trade in the charcoal sector will always frustrate and retard regional efforts for coordinated SFM for charcoal production. This will in turn compromise efforts in reducing deforestation and forest degradation, curbing environmental degradation and impacts of climate change. The

enabling framework that should drive the commitment towards such a paradigm shift would precisely draw on the positive experiences from Madagascar and Namibia, and other countries in SSA such as Sudan and Rwanda, provided there is willingness between countries under the guidance of SADC and COMESA to learn from one another.

According to the research work done on miombo woodlands in the region, the southern Africa ecoregion presents a conducive environment (another enabling 'framework') that could be taken advantage of for informing any policy formulation for implementing SFM for charcoal production. Thus, in spite of the negative impacts alluded to above, such as emission of GHG and deforestation, charcoal and firewood production from miombo woodlands is seen as a temporary problem (Girard, 2002, Malimbwi *et al.,* 2005). This is because, following disturbance caused by firewood and charcoal production, the reduced production pressure can later make such areas progressively revert to woodlands (Malimbwi *et al*., 2005) and in some cases, lead to higher productive miombo woodland ecosystems once disturbances have ceased (Geldenhuys, 2005; Malambo and Syampungani, 2008; Syampungani, 2008). This potentially presents opportunities for developing SFM based on sound rotational harvesting regimes for sustainable charcoal production. Given the experiences from existing charcoal projects in the region (i.e. in Magadascar, Namibia and South Africa) and elsewhere in Africa, and recalling the worth of information from erstwhile but discontinued plantation and woodland charcoal production projects in Malawi and Zambia respectively, the southern African region has a stronger basis than otherwise for embarking on major fuelwood energy policy reforms. These would essentially lead the region to minimise forest losses, develop and implement sustainable methods of extraction and utilization of wood fuels by improving efficiency technologies, encourage use of alternative energy sources and use of plantation species in charcoal production.

4.2.3 Timber

Timber both from forest plantations and natural forests is mainly produced and extracted in the region for wood fuel, industrial round wood and sawn wood as well as for the production of other commercially-important products such as newsprint, wood pulp, printing and writing paper, paper and paperboard, fibreboard, wood based panels and plywood among others (Appendix VIII). Of the three main products, except for South Africa, wood fuel is predominant, enjoying the largest share of timber production (up to 81%) and consumption (up to 95%) across the lead countries in the region (Table 9). This is highly reflective of the African scenario marked by the dominance of "energy" wood products – fuelwood and charcoal that make 76% of the wood products consumed (Chipeta and Kowero, 2015). The 81 - 95% increase in wood fuel consumption in the period 2006 - 2008 mirrors the increase in demand for the same as discussed in Section 3.2.2, further reinforcing the regional state of play of continued demand and consumption into the foreseeable future. However, being

more in the informal than formal market and economic domain, the official statistics on production and consumption of wood fuel as expressed by stakeholders in the study countries, are to a large extent inaccurately or incompletely captured as is characteristic for the rest of Africa (Chipeta and Kowero, 2015). In view of SADC's policies aimed at promoting deeper economic cooperation and integration, this section deals with some of the more formal traded timber products for which reliable and accurate data are available, to help address many of the factors that make it difficult to sustain economic growth and socio-economic development.

Table 9: **The relative production and consumption levels of wood fuel, industrial round wood and sawn wood in the top five lead southern African countries**

Product	Production (1 000 m3)		Consumption (1 000 m3)		Lead Southern African countries
	2006	2008	2006	2008	
Wood fuel	138 005 (82%)	102 130 (75%)	138 005 (81%)	103 133 (95%)	DRC, Tanzania, Madagascar, Zambia, Zimbabwe
Industrial round wood	30 237 (18%)	30 349 (22%)	29 794 (17%)	29 862 (22%)	RSA, Tanzania, Zambia, DRC, Mozambique
Sawn wood	1 144 (0.8%)	3 371 (3%)	3 514 (2%)	3 607 (3%)	RSA, Zimbabwe, Zambia, Swaziland, DRC
Southern Africa Total	169 386 (100%)	135 850 (100%)	171 313 (100%)	136 602 (100%)	

Adapted from FAO (2009, 2011)

The global production and supply of industrial timber appear to be largely dependent on productive forest plantations (IITO, 2005) since a large proportion of the total natural forest area is classified as non-productive or economically non-accessible (FAO, 2006). However, for much of Africa, the timber industry thrives on supplies from both forest plantations and natural forests though timber trade from these sources remain low in spite of its potential for

more trade (Sitoe *et al*., 2010). As a first step in appreciating the context of the timber industry, it then becomes critical to define the forest resource 'envelope', as this provides either the enabling or constraining framework for the development of the industry. In this regard, Table 10 worked from FAO (2010, 2014) data sets presents a summary of forest plantations and related total forest cover for southern Africa for all the 15 SADC member countries including the Comoros.

Overall, the forest plantations in the region are shown to account for about 1% of total forest cover, representing over 3.3 million ha. Approximately over half of these, i.e. 1 763 000 ha are the industrial plantations of South Africa and together with Swaziland and Zimbabwe have a robust plantation sector strongly linked to industrial utilisation (FAO, 2003). Most of the plantation forests in these countries, largely consisting of fast-growing exotic species of pines, cypress and eucalypts, are for industrial purposes and privately owned (FAO, 2010). Botswana, Lesotho and Namibia however do not have commercial plantations except for some small woodlots that were established for the provision of fuelwood and poles for general farm construction (FAO, 2003). More than 85% of the total forest cover is concentrated in less than a third of the countries in the region, i.e. Angola, DRC, Mozambique, Tanzania and Zambia (with > 3 million ha each). About 38% of the countries (i.e., Madagascar, Malawi, Tanzania, Swaziland, Angola and Zimbabwe in that order), have plantations exceeding 100 000 ha; the rest of the region is characterised by a proliferation of smaller plantations.

The huge disparities in the extent and skewed distribution of forest resources to a large extent may present major limitations for the region in the development of a more robust and widespread timber industry particularly in a growing competitive inter-regional, intra-regional and global trade. As noted by Naidoo *et al*. (2013) for example, the expansion of plantation forests in SADC countries is limited by lack of availability of suitable land. This includes for example afforestation efforts in the RSA being limited by water legislation, with most catchments having no further potential for forestry expansion due to this limitation. Other limitations relate to the geo-political make-up of the region, where civil wars in the past such as in Angola and Mozambique have affected the management and expansion of plantations while the current complex political situation in Zimbabwe possibly having significantly reduced the current area of plantation forests (Landry and Chirwa, 2011).

Table 10: Plantation forests relative to total forest cover in Southern Africa

Country	Land area	Forest characteristics (2011)			
		Total forest cover		Planted forest	
	(1 000 ha)	(1 000 ha)	(% of land)	(1 000 ha)	(% of forest cover)
Angola	124 670	58 355	46.8	128	0.22
Botswana	56 673	11 233	19.8	0	0.00
Comoros	186	8	1.4	3	33.30
DRC	226 705	153 824	67.9	59	0.04
Lesotho	3 035	44	1.5	10	22.73
Madagascar	58 154	12 496	21.5	415	3.32
Malawi	9 408	3 204	34.0	365	11.39
Mauritius	203	35	17.3	15	42.86
Mozambique	78 638	38 811	49.4	62	0.16
Namibia	82 329	7 216	8.8	0	0.00
Seychelles	46	41	88.5	5	12.20
RSA	121 447	9 241	7.6	1 763	19.08
Swaziland	1 720	567	33.0	140	24.69
Tanzania	88 580	33 025	37.3	240	0.73
Zambia	74 339	49 301	66.3	62	0.13
Zimbabwe	38 685	15 297	39.5	108	0.71
Total SADC	964 818	392 698	40.7	3 375	0.86

Source: Adapted from FAO (2010; 2014)

The limited scope for expansion of plantation forests in southern Africa in relation to other sub-regions in Africa may seem a drawback in terms of attracting investments for further development of the timber industry. Thus, as depicted in Figure 10, although its natural forest (i.e. naturally regenerated forest and primary forest) with 95.8% cover was the most represented in all of the sub-regions, it recorded the least planted forest area than any other sub-region on the continent (FAO, 2014).

However, in recent times, in spite of the resource constraints mentioned above, the region has achieved some notable positive changes in the production of industrial round wood and sawn wood. From the 1996 – 2012 inter-regional analysis (Table 11), more than half of the countries in the region can be categorised as lead producers, with annual production exceeding 1 000 000 m^3. Consistently, greater volumes than in any other country in the region are shown to have been produced in these lead countries of RSA, DRC, Tanzania, Mozambique, Malawi and Zambia in that order for industrial round wood and in the RSA for sawn wood. Remarkably, the production of industrial round wood and sawn wood in these countries has been steadily growing at an average of 2.3% and 1.7% per annum respectively (Table 11). This signifies an active and growing rather than dormant timber industry with some areas such as in Northern Mozambique registering rapid expansion of forest plantations (Landry and Chirwa, 2011).

In view of the differences in production shown in Table 11, the related levels of consumption and trade between 2006 and 2011 (Appendix VIII) were analysed for countries under study, which also happen to be among the lead industrial round wood and sawn wood producers in the region. There is considerable variation in the production, consumption and trade between these countries, with Zambia leading in industrial round wood production and consumption, followed by Zimbabwe, Malawi and Madagascar in that order.

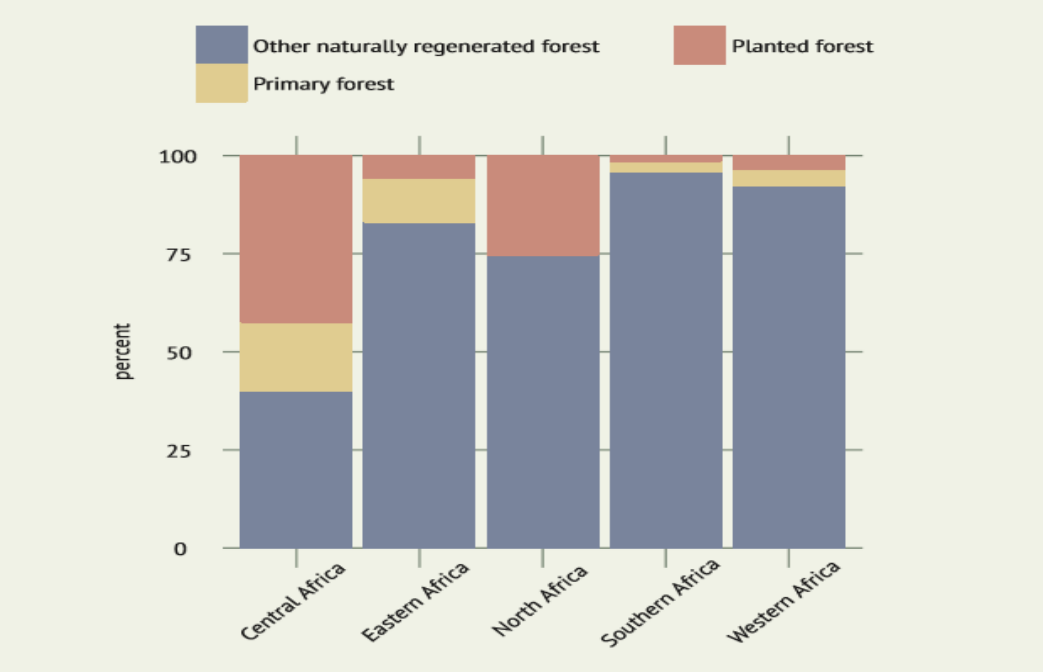


Figure 10: Forest characteristics (2010) in the main regions of Africa

Source: FAO (2010, Global Forest Resources Assessment)

Table 11: **Industrial roundwood and sawnwood production of lead country producers in southern Africa**

Product	Lead Southern African producers	Production	
		Total (1 000 m^3) (2011 – 2012)	% Growth per annum (1996 – 2012)
Industrial roundwood	RSA	17 952	2.4
	DRC	4 592	2.2
	Tanzania	2 314	2.2
	Mozambique	1 416	1.0
	Malawi	1 400	4.6
	Zambia	1 325	3.0
	Angola	1 096	0.9
	Zimbabwe	518	2.0
	Swaziland	330	1.7
	Southern Africa	**31 368**	**2.3**

Product	Lead Southern African producers	Production	
		Total (1 000 m^3) (2011 – 2012)	% Growth per annum (1996 – 2012)
Sawnwood	RSA	1 567	1.8
	Mozambique	198	0.8
	Zimbabwe	177	2.1
	Zambia	157	3.0
	DRC	150	0.1
	Madagascar	104	1.1
	Swaziland	102	1.9
	Malawi	45	2.8
	Southern Africa	**2 531**	**1.7**

Source: Adapted from FAO (2014)

With regard to sawn wood, Zimbabwe produced more than the combined production of all the other study countries, followed by Zambia, Madagascar and Malawi in that order (Table 12; Figure 11). Overall, there was minimal or negative change within study countries, in the production and consumption of industrial round wood and sawn wood with the exception of Madagascar and Zimbabwe where real growth was quite discernible. However, industrial round wood production and consumption across study countries grew by 3.4% and 4.7%, respectively which is above the corresponding average regional growth of 0.4% and 0.2%. The combined sawn wood production and consumption across study countries grew by an average 0.4% and -2.9%, respectively which is below the corresponding average regional growth of 4.2% and 2.7%. These findings show that the region did experience positive growth in both industrial round wood and sawn wood production and consumption, and though sawn wood registered much less volumes than industrial round wood, its growth rate was comparatively much greater (Figure 12A), this being generally over 10 times more amplified.

The observed growth may mirror the socio-economic and environmental outlook of SADC in as far as it relates to increased trade in a number of wood-based products and services, which in turn contributes to developments in the wood-based manufacturing industries and forest management. For example, it was observed by Chipeta and Kowero (2015) that consumption levels of paper and paper board, sawnwood and wood-based panels in Africa which doubled in a span of two decades (i.e., 1990 - 2010), were deemed a reflection of growth in education, construction industry and housing sectors from a rapidly urbanising continent. However, this is not distinctly obvious for the study countries when one considers the low levels of imports and exports of traded industrial roundwood and

sawnwood (Figure 11). This signifies that at a regional level, these countries may seemingly not be the outright, major trading member states in these products. This seems paradoxical when one takes into account the considerable growth and production potential shown for these countries in Table 11.

Table 12: Industrial roundwood and sawnwood production and consumption in 2006 and 2011 in study countries

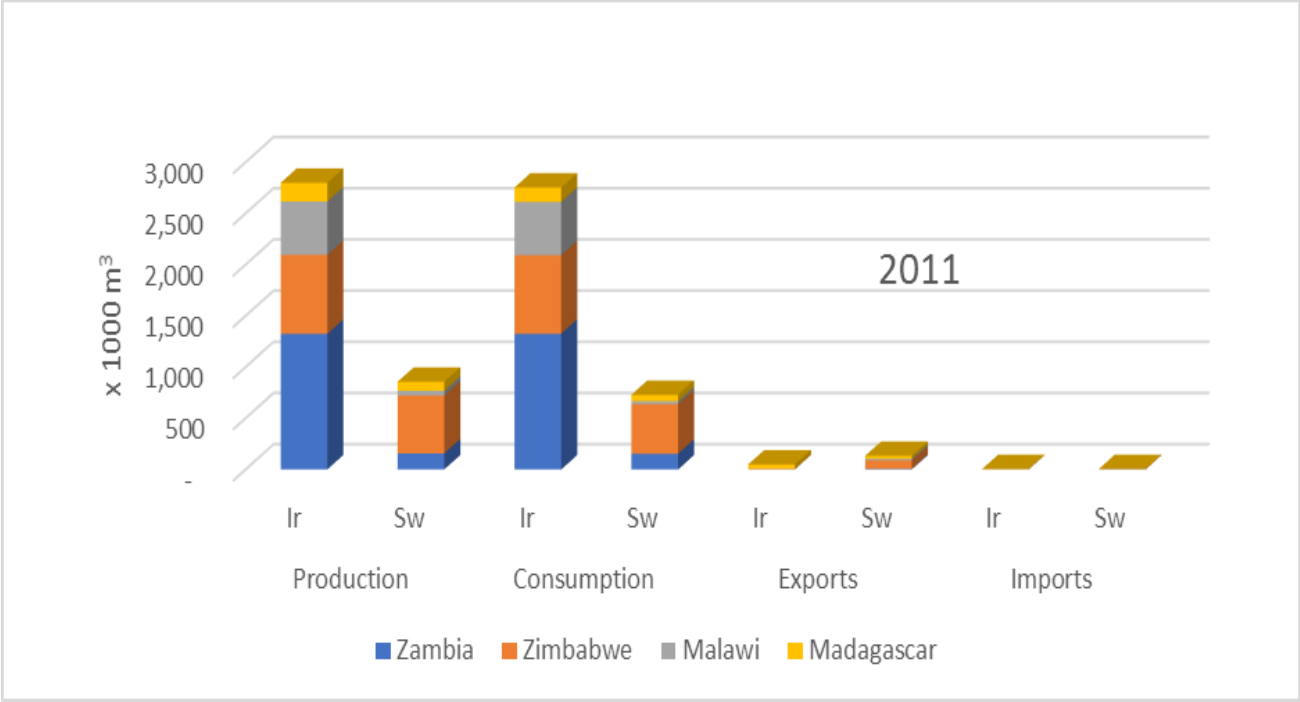
Product	Period	Country/Area				Country totals	SADC	Average country % change	Average SADC % Change
		Madagascar	Malawi	Zambia	Zimbabwe				
IR Production (1 000 m^3)	2006	183	520	1 325	771	2 799	30 237		
	2011	277	520	1 325	771	2 893	30 349	3.4	0.4
IR Consumption (1 000 m^3)	2006	140	521	1 325	767	2 753	29 794		
	2011	277	511	1 324	770	2 882	29 862	4.7	0.2
Sawnwood Production (1 000 m^3)	2006	89	45	157	565	856	3 235		
	2011	92	45	157	565	859	3 371	0.4	4.2
Sawnwood Consumption (1 000 m^3)	2006	62	29	153	484	728	3 514		
	2011	58	0	137	512	707	3 607	-2.9	2.7

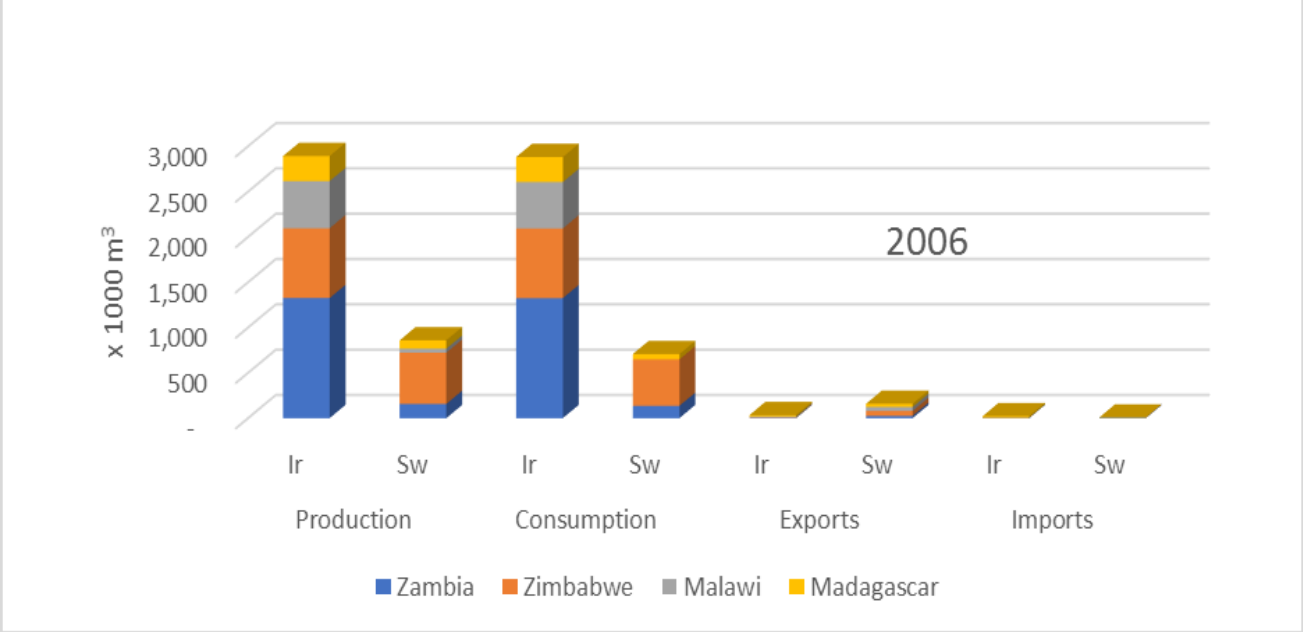
The paradox of the considerable production potential and related, dismally low levels of imports and exports of traded industrial round wood and sawn wood (Figure 11) is symptomatic of the emerging scenario in intra-African trade in forest products (Chipeta and Kowero, 2015), which is characterised by very small volumes of recorded trade on one hand, and on the other one of unrecorded and of potentially big sales taking place across borders. The cross-border transactions between Malawi and Tanzania for exports of sawn wood to East Africa is a fitting illustration. In the 2008/09 season, Kafakoma and Mataya (2009) estimated 14,269 m^3 of exports to East Africa with total costs of US$ 3.2 million and expected sales revenue of US$ 7.5 million. In the same period, the Department of Forestry reported exports of 11,050 m^3 valued at US$ 0.6 million. The Department of Forestry figures also showed similarly smaller quantities of exports to the RSA, Mozambique, Zambia, Botswana and Malaysia. The disparities in total timber exports between what the Department of Forestry recorded and what Kafakoma and Mataya (2009) found meant that huge volumes of timber exported were not recorded by the Department of Forestry. The implications on reduced revenue capture from timber exports, the restrained contribution of

the timber industry to total foreign exchange earnings and GDP, and the cumulative effect on the production and supply of timber and fuelwood cannot therefore be ignored.

In order to overcome the low levels of production and trade, stakeholders in the study countries expressed the need for countries to make substantial progress in trade commensurate with the available resources by significantly increasing investments or reinvestments and improving capacities in forestry production while at the same time overcoming a number of infrastructural, institutional and governance limitations. Stakeholders however noted the enormous challenges that individual countries could face in trying to single-handedly overcome such limitations. Nevertheless, noting the success of other countries in the region in wood and wood products trade, e.g. the RSA and Swaziland, stakeholders strongly underscored the need for greater inter-regional collaboration through SADC and COMESA in the exchange and transfer of technologies and expertise between countries for improved trade and forestry management.

To reflect on the above stakeholder views, the study examined the regional perspective on trade by analysing data from FAO (2005, 2009 and 2011). The picture that emerges for the region is that of increasing sawn wood exports (by 1.9%) and imports of industrial round wood (by 18.1%), with the magnitude of the traded sawn wood volumes being much greater (i.e., more than treble) (Figure 12B).

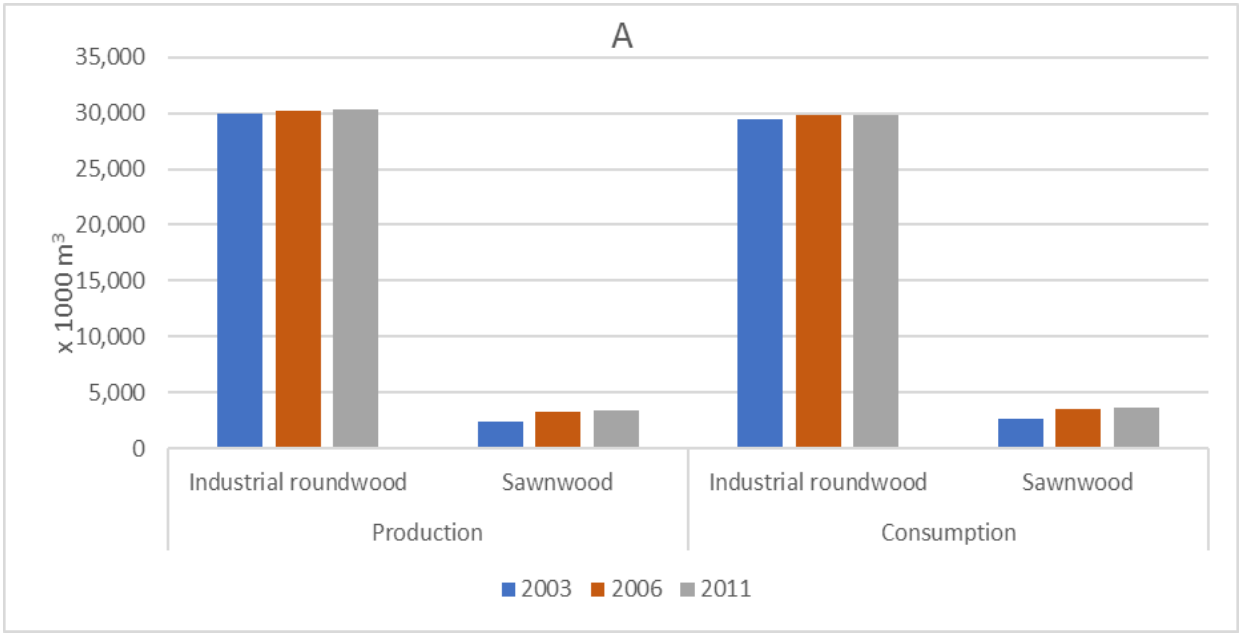




Note: Ir = Industrial round wood, Sw = Sawn wood

Figure 11: Production, consumption and trade volumes (x 1000m^3) of industrial round wood and sawn wood in the study countries in 2006 and 2011. Adapted from FAO (2009; 2011)

Due to the much larger volumes shown here than depicted for study countries in Figure 11, the influence of other countries to these growing trends is apparent. For example, when the sawn wood exports for the RSA as a lead producer in the region are juxtaposed against those of SADC (Figure 13), much of the noted increase can be attributed to the growing sawn wood industry in the RSA, with as much as 88% of the share in trade attributed to it. This is not surprising considering that the RSA clearly dominates the region in terms of exports to all the major markets such as the European Union (EU), Japan, North American Free Trade Agreement (NAFTA), East Asia and China (SADC, 2016). Overall, much more could be done to take advantage of these markets not least the booming Chinese economy which requires massive amounts of raw materials for their bourgeoning housing construction and furniture industries. As SADC seeks greater regional integration as also espoused by the stakeholders, countries in the region should indeed learn from the RSA (which exports over 90% of the continent's plantation-grown products), Swaziland, DRC, Mozambique (with more than 90% of its timber products exported to China) and Tanzania, which have made a mark in trade in industrial round wood, sawn wood and other wood products such as pulp and paper (Canby *et al*., 2008; Xiufang, 2014).



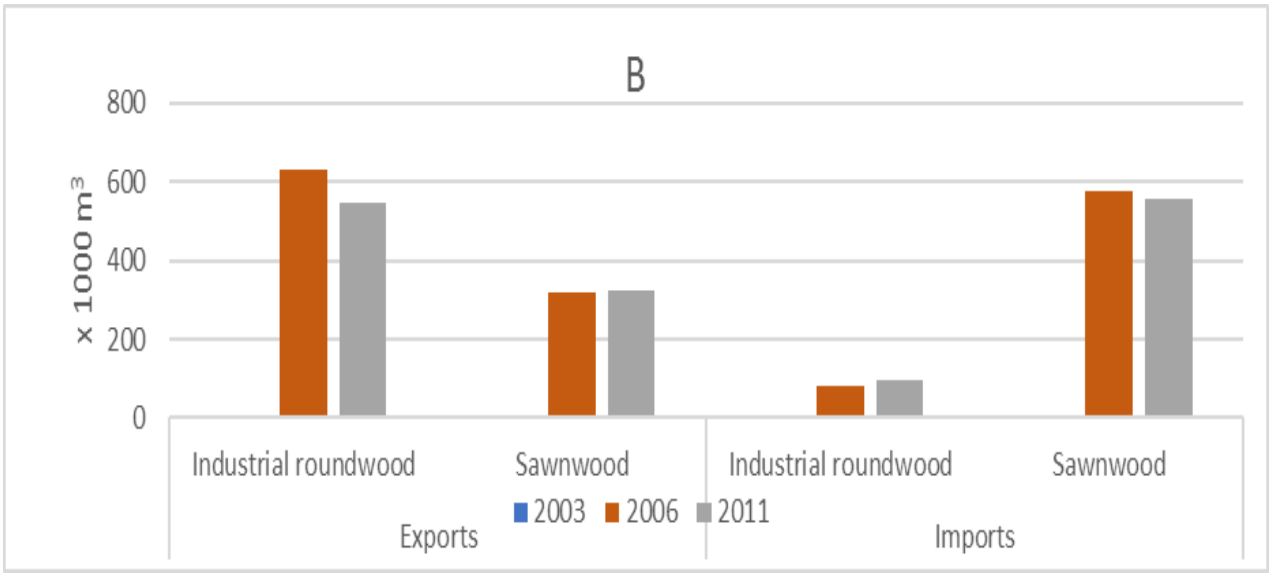


Figure 12: Production and consumption (A) and trade (B) volumes (x 1000m^3) of industrial round wood and sawn wood in the SADC region in 2003, 2006 and 2011. Adapted from FAO (2005; 2009; 2011)

From a global perspective, there are growing signs that southern Africa could gradually make improvements in timber trade and that both SADC and COMESA have a dual responsibility of developing robust and improved regional timber industry and trade. For instance, in the period 1962-2012, the African region had a 2.5% share of the total global growth in industrial round wood which increased towards the end of this period i.e. 2011-12, to 4%. Of this, southern Africa had the largest share of production (34%), followed by West Africa (25%), with the other sub-regions sharing the remainder: 21% for Central Africa and

19% for East Africa. Notably, among the biggest producers of round wood (Egypt, Ethiopia, Ghana, Kenya, Nigeria, Sudan and Uganda) whose production ranged between 15 300 and 106 901 thousand cubic meters, were the southern African countries of the RSA, Mozambique, DRC and Tanzania. With regard to sawn wood, southern Africa had a share of 30% of production in Africa, only coming second to West Africa, the biggest producer with 46% of production. Correspondingly, southern Africa experienced some significant growth in the exports of forest products between 2000 and 2012, such that Mozambique for example regarded as Africa's fourth-largest timber exporting country to China, increased its exports to the country by seven times, mainly in the form of logs and sawn wood, though recently there has been a downward trend owing to a ban imposed on the export of logs in 2015 and to the economic changes in China (AfDB, OECD, UNDP, 2016).

It is however important to note that the relative importance of the export markets and therefore the magnitude of trade in industrial round wood and sawn wood varies greatly between regions and individual countries mainly due to the differences in forest resources, geography and economic development (Hillring, 2006). The exploitation of these markets by the above-mentioned few countries in the region should inevitably present special integration challenges to SADC and COMESA, the two major regional economic communities (RECs) promoting the regional integration agenda.

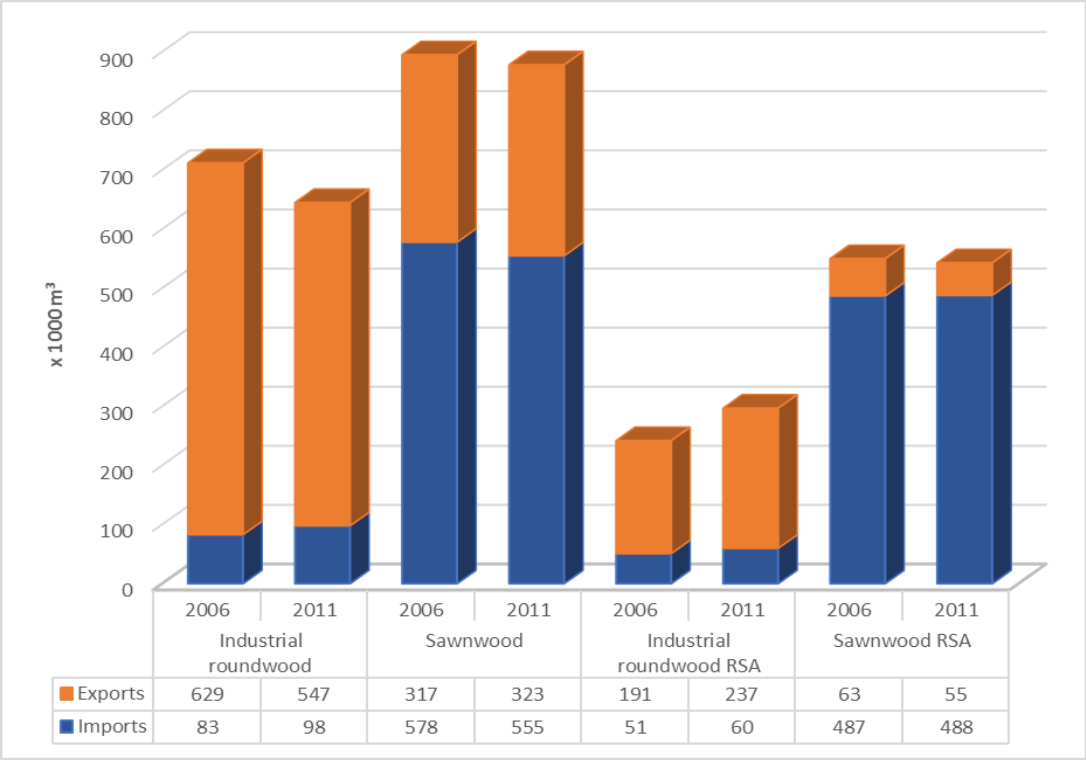


Figure 13: Trade volumes (x 1000m^3) of industrial round wood and sawn wood in the SADC region and South Africa in 2006 and 2011. Adapted from FAO (2009; 2011).

These challenges become more pertinent as SADC's own Protocol on Forestry seeks to "promote trade in forest products throughout the region in order to alleviate poverty and generate economic opportunities for the peoples of the region". At the same time, COMESA's forestry strategy upholds the elevation of the forestry sector in terms of contribution to local, national and regional economy through improved integration and trade. These challenges are however not uncommon to the rest of Africa as Chipeta and Kowero (2015) argue that the weak integration of regional and even sub-regional trade in forest products and services in the continent are critical issues that must be attended to. They contend that these plus some restrictive transboundary forestry related activities generate scarcities in many countries and even within countries for a number of reasons such as weak trade infrastructure, trade restrictions, domestic laws and regional protocols not fully adhered to, relaxed enforcement of law and regulations, lack of customs capacity to administer, monitor and control timber trade, among a plethora of other reasons.

In view of these seemingly debilitating challenges, the magnitude and pace of intra-regional and international trade in a number of timber products is far below full capacity for most countries on the continent and must be improved. For most countries in southern Africa, the intra-regional trade involves processed forest products, mostly paper, plywood and fibreboards, furniture, doors, fittings and joinery. Comparatively, the SADC bloc has the highest intra-regional trade compared to the other African RECs (19.9% for export and 33.1% for imports), although it is mostly directed towards the RSA. That as it may, SADC must improve its trade with the rest of Africa which has hitherto been regarded as the lowest (2.3% for export and 2.6% for import). At the same time, trade with the rest of the world while regarded as improving and more important for the sub-region, remains insignificant in global terms, with total trade volume representing only around 1% of total world trade (AfDB, 2011).

For the region to make strides in improving timber trade beyond these thresholds would imply taking on new strategies in terms of production and trade. This behoves, for example, re-strategizing in order for the region to tap into a ready market that Africa provides, particularly in north Africa where potentially big markets relying on imports from Canada, Russia, France, Sweden and Germany exist. Re-strategizing in this case would have to include as Chipeta and Kowero (2015) alludes to satisfying the north African market by matching the type of timber it consumes most (most likely construction and not decorative varieties), with requisite facilities for its production. It also has to involve addressing constraining factors to reaching markets in the absence of and/or presence of poor infrastructure between north African countries and south of the Sahara. Admittedly, Chipeta and Kowero (2015) contends that these are not issues that can be addressed by the forestry sector; rather they can be addressed within the broader context of current efforts to increase regional socioeconomic integration in Africa that also has potential to promote intra-African trade.

Part of the new production and trade strategies that the southern African region must undertake to improve intra-African and regional trade regards addressing governance, including policy and institutional factors, which stakeholders interviewed claimed to be primarily responsible for causing poor management of the timber industry and trade, leading to further deforestation and forest degradation. The main areas of concern in the region, among others, have been lack of clear policies related to the timber industry, unresolved issues of equitable and secure timber rights; vested interests; policies focusing largely on economic growth generated by industrial development at the expense of sustainable timber production; weak and non-integrated sector policies impinging on the timber sector; policies addressing different environmental aspects often not coordinated; and weak and centralized regulatory systems. Two examples, among many cited by stakeholders interviewed, reflecting policy and institutional factors worth noting can be summarised as follows:

i) In Zimbabwe, the productivity of and trade in the timber sector have significantly declined in recent years due to over-exploitation and degradation of the indigenous forests in both the commercial and resettlement areas most markedly following policy changes in land tenure associated with the Land Reform Programme. As a result, this is said to have contributed to the national annual rate of deforestation which accelerated from 100,000 ha per year in the 1990s to the current 327,000 ha or – 1.9 % per annum (also in ZNCCRS, undated).

ii) With regard to government plantations in Malawi, vested interests, and institutional and governance weaknesses saw stumpage fees charged by government for extracting timber over three-year price review cycles (between 1994 and 2010) pegged at less than one quarter of the breakeven price of incurred costs for growing timber. This has over the years led to massive depletion of the 53,000 ha of Chikangawa Forest Plantation and many other plantations. Similar governance and legislative weaknesses have been observed in Zimbabwe and Zambia, leading to substantial reduction in sustainable timber production and with it negative environmental and climatic change. This has mainly been evidenced by massive soil erosion, reduction in fisheries in lakes due to sedimentation of fish breeding grounds, flooding and droughts further downstream and subsequent reduced agricultural output resulting in food insecurity.

Overall, the process towards closer integration in addressing timber production and trade in the continent and regionally would, most importantly, demand closer cooperation within and between RECs, such as Economic and Monetary Community of Central Africa (CEMAC), COMESA, EAC, Economic Community of West African States (ECOWAS), Southern African Customs Union (SACU), SADC and West African Economic and Monetary Union (WAEMU), preferably under the trade areas Tripartite Free Trade Area (TFTA) and Continental Free Trade Area (CFTA), which are designed to spur intra-regional trade and investment. This would also enable Africa to overcome limitations of too many small and fragmented markets, the huge differences within and between Africa's regions, the varied

limited levels of trade integration within economic zones, the lack of economic diversification necessary to achieve the economies of scale necessary to compete internationally and in the continent. Lining appropriate policies are critical to addressing these important issues of integration hence the need for policy makers to quickly address these key issues, aimed at developing greater intra-African trade, which at the moment remains the lowest among all the continents (AfDB, OECD, UNDP, 2016).

4.3 THE NEXUS OF FOOD, FUEL AND FIBRE: COMPETITION ON BIOFUEL PRODUCTION

Although wood fuel as observed in Section 3.2.2, will continue to be the most important source of energy for the foreseeable future for Africa and the region, there is clearly some interest and demand for domestically produced biofuels for a variety of reasons. As drivers triggering biofuels developments, such reasons vary between countries and regions but from the SSA policy dialogue perspective, these have been identified as mainly four-fold. Namely, these relate to their potential for rural development, energy security, their ability to attract appropriate investments and potential for sustainable land use (von Maltitz and Stafford, 2011; Farioli and Ippolito, 2012). An evaluation of the key drivers, analysed from various source documents (e.g., FAO, 2010; Karavina *et al*., 2011; von Maltitz, 2013; Chakaniza, 2016; Chinsinga, 2016) and stakeholder interviews for the countries under study and the southern African region, brings forth comparable but more numerous number of reported drivers considered important. As illustrated in Table 13, there are at least four key drivers registered per country, signifying the existence of multiple goals for the interest and demand for biofuels development in the region. Except for reasons of technological progress and research, six drivers have been identified as common key drivers across the countries. Similar to those referred to in Section 2.2, these relate to six major drivers of climate change (e.g. reduction of GHGs) and environmental sustainability; energy security particularly in reducing dependence on imported petroleum products and forex bills; rural development (e.g. resulting in employment creation and poverty alleviation); investments and increase of local markets; and availability of suitable land.

On a regional scale, availability of suitable farms (mainly evident in Mozambique and Tanzania) and technological progress and research (as in Botswana, RSA and Zimbabwe) appear to overall have acted as one of the least drivers for policy decisions on biofuels development. The absence of the latter implies that the majority of the countries in the region mostly relied on and were influenced by the extensive global interest and technological/research evidence on the potential of biofuels development. This has been most evident with the adoption and production of biodiesel from jatropha, against which there have been calls for extensive research to enable evidence-based decision making (e.g. Brent *et al*,2008; Shumba *et al*, 2009; von Maltitz and Staffford, 2011; Von Maltitz *et al*,

2014).Weighed against the 'pull' of the so many drivers, most countries were too eager to realise the perceived potential benefits that it is perhaps understandable why there has not been much extensive research done, particularly considering the huge cost implications for research and technological development for these countries.

A summary of the status of jatropha production initiatives in the region (e.g., Sulle and Nelson, 2009; German *et al*, 2011; Karavina *et al*, 2011; von Maltitz *et al*, 2014) updated by information from stakeholder interviews (Table 14) paints a positive narrative of initially promising jatropha production and development initiatives with commitment and involvement of the private sector, governments and local communities or farmers seeking to realise the benefits depicted in Table 13. However, it is worth noting that in spite of the various levels of commitment in support for jatropha biodiesel production, most countries experienced difficulties such that some of the small-scale and large-scale commercial plantations appear to have been short-lived. As shown in Table 14, also noted in other studies on jatropha projects in the region (e.g., German *et al*., 2011; Locke and Henley, 2013; von Maltitz *et al*, 2014), most jatropha projects in the region have stalled. In the extreme, these have either partially (or totally) collapsed (e.g. in Zambia, Zimbabwe and Tanzania), have substantially reduced their levels of investment (e.g. in Malawi, Tanzania and Namibia), or have been sold out to new investors at a fraction of the initial investment (e.g., Mozambique) (von Maltitz *et al*, 2012; Locke and Henley, 2013).

Table 13: **Drivers for biofuels development in southern Africa**

Country/Area	**Objective/Drivers**						
	Climate change/ Environment	Energy security	Rural development	Availability of suitable farms	Extensive global interest	Investments/High Economic Returns/Increase local market	Technological progress/research
Study Countries							
Madagascar	×	×	×	x	x	x	
Malawi	×	×	×	x	x	x	
Zambia	×	x	x	x	x	x	
Zimbabwe	×	x	x	x	x	x	x
Other SADC countries							

Country/Area	Objective/Drivers						
	Climate change/ Environment	Energy security	Rural development	Availability of suitable farms	Extensive global interest	Investments/High Economic Returns/Increase local market	Technological progress/research
Angola	×		×		x	x	
Botswana	×	×	×		x	x	x
Mozambique	×	×	×	×	x	x	
South Africa	×	×	×		x	x	x
Swaziland	×	×	×		x	x	
Tanzania	×	x	×	×	x	x	
SADC	**x**	**x**	**x**	**x**	**x**	**x**	**x**

Overall, Table 14 shows that the reasons behind the collapse of jatropha projects in southern Africa stem from inadequate scientific research knowledge as a basis for its development, lack of financial viability, low overall profitability, weak national institutions and lack of appropriate policy and institutional frameworks. Considered together with country specific challenges, these have made the region unable to achieve the levels of biofuel production as expected. For example, in Mozambique most investors pulled out due to the emerging food-vs-fuel and land-grabbing debates combined with the increasing scrutiny over biofuels' social and environmental benefits. As collaborated by other investigators in the region (e.g., Mitchell, 2011; Nielsen *et al,* 2014; van Eijck *et al*, 2014), these have meant that biofuels were no longer being portrayed as socially and environmentally appropriate investments, further undermining investor support.

In spite of the noted withdrawal of technical and financial support by investors and other setbacks for the development of the biofuel industry from jatropha (Table 14), there have been some notable signs of resilience and promising vitality. Von Maltitz *et al* (2014), for example, report on BERL in Malawi and Niqel in Mozambique as two of the few jatropha projects that have not collapsed but shown signs of long-term viability in southern Africa. Bio Energy Resources Limited (BERL) and Niqel, smallholder-based, hedgerow growing surrounding farmer crop fields and commercial plantation models respectively have registered relative success in terms of sustainable and viable land use options for growing

jatropha. BERL was one of the projects visited in this study and a summary of key features of its progression from inception (Table 15) is given as one way of measuring its resilience and long-term viability. Based only on hedgerow or boundary plantings which started in 2008, BERL's vision was dependent on modest seed yields from mature trees, gradually increasing to sufficiently high and reliable quantities for financial viability. This approach is similar to that adopted by Niqel in Mozambique (von Maltitz *et al*, 2014), signifying a more cautious move towards the development of the industry; dissimilar to most of the stalled projects in the region (Table 14).

Table 14: **Status of jatropha production initiatives from selected countries in southern Africa**

Country	Prior research studies and institutional framework	Production and developmental initiatives	Current status
Madagascar	No specific regulatory framework/policies for biodiesel	• A number of large-plantation projects initiated, some with the most extensive large-scale land allocations for jatropha in the region (928,610 ha) • Examples: 452,000 ha by GEM Biofuels; 100,000 ha by Tozzi Green, boasted the largest jatropha nursery in the continent.	• Halted cultivation in 2013 due to political instability and low yield; • Not clear how many projects materialised.
Malawi	No specific regulatory framework/policies for biodiesel	• Biodiesel Agricultural Association formed in 2005, advocating cultivation of biodiesel crops (apparently promoting the planting on behalf of D1 Oils Africa (Pty) Limited); Few plantation projects initiated, main focus on smallholder projects, often planting jatropha as hedgerows; • 2007, Janeemo, a	• On-going smallholder-based project by BERL; • BERL contracts with 25,000 smallholder farmers; • Original investors withdrew support and funding; weak institutional capacity; • Sugarcane ethanol dominating market; jatropha production just a

Country	Prior research studies and institutional framework	Production and developmental initiatives	Current status
		Scottish-funded initiative supporting incorporation of tree crops (including jatropha) into the smallholder sector; • BERL in 2002 launched to produce biodiesel to be blended with 4% imported diesel. • BERL started project, technical assistance from Government., Lilongwe Technical College & Universities in Netherlands; • BERL granted approval to manufacture, sell and distribute jatropha diesel in 2015.	fraction of biofuels produced.
Zambia	No specific regulatory framework/policies for biodiesel	• Marli Investments and Oval Biofuels, two early promoters to engage farmers in outgrower-based and smallholder-based jatropha production; • Promotion and wide-scale planting nationally in 2004 by Biofuels Association of Zambia; Southern BioPower and D1; By 2009, farmers planted 1.6 ha on average.	• Much of the initial support from companies and government ceased; so too funding.
Zimbabwe	Extensive research but no specific regulatory	• Research done by Scientific and Industrial Research	• Jatropha does not threaten food

Country	Prior research studies and institutional framework	Production and developmental initiatives	Current status
	framework/policies for biodiesel	and Development Centre, Masvingo and Harare Polytechnic Colleges, the National Oil Company of Zimbabwe (NOCZIM) and Environment Africa; • Massive promotion by Ministry of Energy through NOCZIM and Forestry Commission; • Research and Government publicity resulted in establishment of Mt. Hampden biodiesel plant and a number of oil pressing mills; • Mt. Hampden biodiesel plant, capacity - 70,000 L/month of diesel for 10% fuel import substitution; large hectarages planted by 2005; • Government. plantation establishment target of 120,000 ha by 2010, spearheaded by NOCZIM; 2,000 ha planted by 1997, 35,000 by 2009.	security; • Moribund due to lack of policy direction, no regulatory framework, discontinued Government promotion/funding; poor coordination in the biodiesel sector; unfavourable prices; political instability; most biofuel efforts dominated by sugarcane ethanol. • **Refer to Box 1**
Botswana	On-going research	• Research with support from Japanese International Cooperation Agency;	• Awaiting research outcomes before further developments.

Country	Prior research studies and institutional framework	Production and developmental initiatives	Current status
		• Most jatropha related-activities remain at research level; a more cautious developmental approach.	
Mozambique	Comprehensive biofuel strategy developed in 2009	• In 2004 Government interest started mostly through private sector drive; Government distribution of seed to farmers; • In 2009, 12 official jatropha investment proposals for 179,404 ha, with a further 19 projects not formally lodged with government.; • Large-scale plantations, e.g., Niqel Lda., Niqel plus a few small-scale projects (Envirotrade, FACT Foundation).	• Most investors pulled out large-scale production following controversies that jatropha takes as much land as food crops do, though some are still operational.
RSA	Extensive research: potential for invasiveness	Studies done by: • D1 Oils S.A. (Pty) Ltd, Imvubu Agric Enterprises (Pty) Ltd (D1); Water Research Commission (WRC) 2004 – 2005	• Effectively banned in 2007 over fears of invasiveness.
Tanzania	No regulatory framework/policies for biodiesel	• Bioshape, Sun Biofuels, D1 Oils and GEM Biofuels smallholder plantations with communities	• Bioshape divested amid allegations of complicity in illegal hardwood harvesting; • Sun Biofuels, D1 Oils and GEM Biofuels stopped

Country	Prior research studies and institutional framework	Production and developmental initiatives	Current status
			operations; shares collapsed.
Namibia	No regulatory framework/policies for biodiesel	• Embarked a number of projects; four main projects reported during the early stages of expansion; • One such project later abandoned its plantation, eventually removing already planted trees as it was not possible to reach an agreement with the government over land tenure; • Private investors worked with traditional authorities to establish plantations on communal land.	• Assessment suggested only low yields could be expected, jatropha unlikely to be financially viable; • Cultivation apparently banned awaiting further research.

The adopted approaches of modest hedgerow-growing and feedstock yields, against the enormous hype and drive for jatropha, appear to have provided a viable option in addressing the concern of competition for land with agricultural crops (Table 15). This is to the extent that the long-term vision of BERL of achieving increasing seed yields from mature trees appear to have been realised since inception in 2008. After nearly 8 years, as more mature trees increasingly produced more seed, BERL has from 2016 reported seed yields ranging from 5 to 14 t/ha per annum, up from 0.1 to 0.5t/ha per annum achieved in the first year of harvest by farmers. This is comparable to 8-12 t/ha per annum under high management in other countries (Esterhuizen, 2010). The current BERL yields surpass the targeted 1.9 t/ha per annum set by the project with a projected production of 1 million litres of biodiesel per annum.

It is therefore envisaged that these recent production levels are sufficiently high and reliable enough to ensure financial viability and substantially contribute towards achieving the overall national 2030 biodiesel production target of 110 million litres per annum. At the same time, the end use and expected blending target has improved from 8%, at the start of the project to between 9 and 10%, with national distribution done by ENGEN, most of it being supplied to Phillip Morris and ALLIANCE One Tobacco Company. These supply chains have so far helped to keep production afloat and satisfy out-grower farmers, who have been frustrated by infrequent feedstock purchases by BERL. Given the support from the above companies, the needed financial support from the formed alliances and the appropriate policy and legislative frameworks from government, BERL is convinced that its setup is one of the best examples for the sustainable production and supply of bio-diesel from jatropha.

It is however apparent that BERL's current biodiesel production capacity of 200,000 litres per annum, under such high seed yields is hugely constrained by seed supplies. The less than expected production volumes are a factor of limited cash flows to buy all the available seed from farmers, following the withdrawal of investor support. Buoyed by the increased seed yields, continued farmer participation and commitment and enormous potential for increased biodiesel production, BERL is however attracting new investors through South African capital investor brokers. Additionally, BERL has teamed up with the Jatrosolution Company of Germany for the production and supply of high yielding, hybrid jatropha seed.

An examination of the BERL project shows that through contractual agreements, the shared cultivation costs and other overheads between BERL and farmers such as extension services, use of Clean Development Mechanism (CDM) financing, "soft" loans and support from corporate social responsibility programmes, use of contracted seed buyers to purchase seeds directly from the farmers in remote areas (for BERL) to reduce the opportunity cost of time for farmers to transport seeds to centralised selling points were some of the essential elements identified for ensuring long-term financial viability. Strategically, BERL positioned itself to work with subsistence farmers, offering only small areas of their farms for hedgerow planting in 8 districts of Malawi which are predominantly vulnerable to high food insecurity. This was deliberately intended to allow farmers sell their seed to BERL for additional income to enable the poor households purchase food during the 'lean' most food insecure period of the year. It is now clear that despite the factors working against jatropha biofuel development (Table 14), this 'safety net' provided by this approach has had a positive impact on food security to the farmers and probably contributed to the resilience of the BERL project. Additionally, there have been no known evidence for the time being of the competition between jatropha cultivation and food crop production (von Maltitz *et al*, 2014).

Table 15: **Progression of operations by BioEnergy Resources Ltd. (BERL) in Malawi.**

Characteristic	Progress from inception (2008)	2016 Updated progress
Establishment	Established in 2008 with operations in 8 of the 28 districts in Malawi; built factory in 2012	Joint financier withdrew, 2013
Coverage	Smallholder-based project; hedgerow planting and management by farmers themselves, numbering 25,000 in 8 districts of the country, with prospects to increase farmers over time	A total of 30,000 farmers engaged but reduced buyers/extension staff retrenched in 2013; now only 4 left; original investor, Dutch TNT, withdrew support in 2013
Biodiesel production (Target of 1 million L/year; Overall national 2030 target of 110 million L/year)	Plant set in modular form, increasing over time dependent on supply of seed. A total of 15,000 to 20,000 litres/week initially produced	A total of 200,000 L/year as initial levels of biodiesel production not sustained due to financial flow problems and lack of venture capital
Blending (Started with 8% blend)	Blended from 8% up to a maximum of 9%	Up to 10% blend achieved, certified and sold to motorists
Annual seed yield Target of 1.5 kg per tree per annum, equivalent of 1.9 t/ha (at 1250 trees/ha) per annum	Reported average annual yields ranging between 0.05 to 0.4 kg per tree, i.e. between 0.1 0.5t/ha per annum	Reported average annual yields ranging between 4 to 11 kg per tree, i.e. between 5 to 14 t/ha per annum
Impacts	No negative impacts envisaged; farmers restricted to hedgerow planting under contractual agreements with BERL	No known evidence of competition for land with food crops as growing of jatropha is still limited to hedgerows. Farmers benefiting from additional incomes through sales; food secure in 'lean' food insecure months of the year

Box 1: Aborted Jatropha project in Zimbabwe

The production of Jatropha for bio-diesel may create problems into the foreseeable future as uptake is not there, mainly due to food scarcity problems in Zimbabwe, aside from lack of markets. Though there was enormous government drive, sanctioning and investment arising from 'Zimbabwe's fuel crisis', jatropha production was and is still not a priority among people struggling to find food for survival. Jatropha has also been seen as a threat to agriculture, the economy and environment as the same labour is shared for its production and food production. The impact has been felt as affecting the social patterns, as land issues come to the fore, leading to land shift between food and jatropha production.

A good example to explain this is from Ngwenya area, where chiefs stopped the growing of Jatropha and encouraged their subjects to grow maize instead. Partly, this was because government did not properly communicate its development policy on the virtues and benefits of growing Jatropha. It was apparent that this was due to lack of any particular studies or experiments and therefore adoption of the policy was hurried. As it turned out, the production cost of Jatropha at the commercial price of $4 per litre was very high and does not work at all.

The policy formulation process done in difficult times based on a crisis of fuelwood shortage in the country without sitting down to thoroughly plan and experiment, with government officials themselves tending to play along and 'believe anything' for fear of being politically misunderstood as acting 'against government', saw the construction of two giant Jatropha Plants which have basically become white elephants in Mutoko and Mt. Hampden with all operations halted.

Though Shonhiwa (2015) reports that in some of the southern African countries such as Angola, DRC, Mozambique, Tanzania, Zambia and Zimbabwe, land is still abundant such that production of energy crops will not disturb food production. Table 14 highlights the case of Malawi and Mozambique where for the former, jatropha is restricted to hedgerows and in the case of the latter, investors pulled out of large-scale production due to controversies that jatropha takes up as much land as food crops. For some countries such as Madagascar, Malawi, Zambia and others (Table 14), competition for land with food crops and issues surrounding land security and biodiversity habitat require further investigation. The government of Zambia for example being aware of the controversy of land versus food security, has rather been lukewarm in committing effort and investment in the production of jatropha. However, it has maintained an open-door policy for anyone wanting to venture into the jatropha bio-fuel industry (Mateyo Kaluba, Ministry of Commerce, Trade and Industry, Zambia). In most cases however, what appears to be the major argument is that

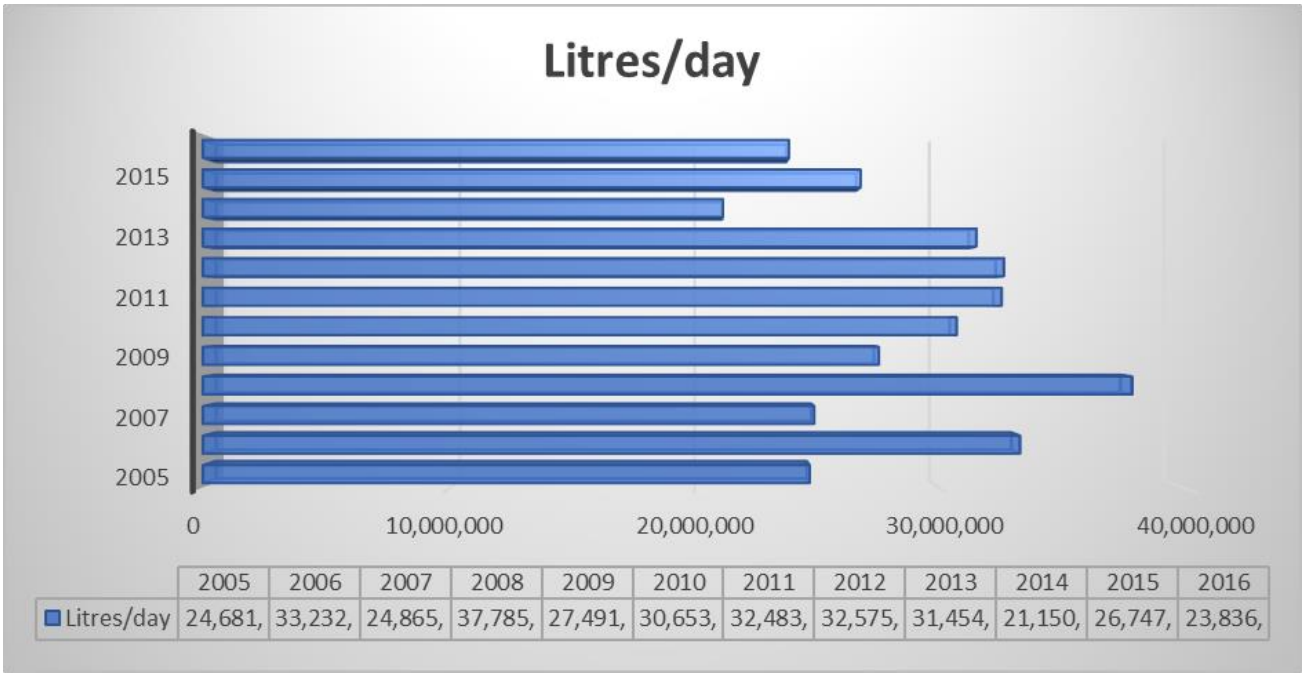
biofuels require large tracts of land to produce feedstock hence they are perceived as an emerging driver of habitat alteration, biodiversity loss, food insecurity and community displacement and disenfranchisement (Shumba *et al*.,2009; Shonhiwa, 2015).

Though the examples given above do not offer any substantiated evidence with regard to impacts on fuel security and foreign exchange, particularly in landlocked poor countries in southern Africa like Malawi, von Maltitz *et al.* (2014) presumes that these are likely through growing of jatropha in modest amounts as is the case with the BERL project. The resilience shown in the BERL project is perhaps contingent upon such projects being financially viable but also being fully embraced by local farmers, the producers and suppliers of the seed. Viability also hinges on support from governments through creating an enabling policy environment to attract investor support for extensive research and development. Governments in addition need to provide incentives for the development of proper markets and better protect local communities by ensuring that they (or their land) are not exploited. This means that governments in southern Africa have a fine balance to strike between attracting investments and at the same time ensuring the costs and benefits of jatropha production are justly distributed.

In the case of bio-ethanol produced from sugarcane molasses from both large scale commercial farms and smallholder out-grower schemes, the region has been more successful in the production of this biofuel than that of biodiesel from jatropha. Quoting the 2011 EIA International Energy Statistics Renewable Database, Henley (2014) refers to Malawi (producing 31,700 litres per day) as the largest ethanol producer in the region, followed by South Africa (15,900 litres per day) and Zimbabwe (3,200 litres per day); respectively ranked 42nd, 49th and 52nd globally. Although Malawi is said to have consistently produced around 32,000 litres per day since the 1980s, there has been some significant fluctuations in production over the years, largely owing to different levels of feedstock supply. Using data from one of the ethanol producing companies in Malawi, Ethanol Company Ltd, Dwangwa (the other being PRESCANE operating at Nchalo), Figure 14 shows that between 2005 and 2016, production fluctuated between 21,000 and 38,000 litres per day.

The volatility and lack of consistency in production is also exhibited in other countries in the region due to different reasons. These range from current production and investment plans not being implemented (e.g. Mozambique, Zimbabwe and RSA), unexplored opportunities to produce fuel ethanol by upgrading existing manufacturing plants in Zambia, to poor weather in Zimbabwe as happened in the 1980s when production was around 95,000 litres per day but a drought in the early 1990s brought production almost to a halt (Henley, 2014). These mixed signals imply that the region is operating below its full capacity and that there is potential for much greater levels of ethanol production which could easily help countries attain or exceed their domestic mandatory blending targets (Table 16). The mandatory blending targets in Table 16 show that ethanol produced under varying regulatory

frameworks in the region for industrial and potable purposes both for local consumption and export, is blended with imported fuel to differing mandatory levels ranging from 5-20% (also termed as E5-E20) across the main country producers in the region.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Litres/day	24,681,	33,232,	24,865,	37,785,	27,491,	30,653,	32,483,	32,575,	31,454,	21,150,	26,747,	23,836,

Figure 14: Levels of ethanol production by Ethanol Company Ltd, Dwangwa, Malawi

The sugarcane industry in the region is generally regarded as well-established and competitive and steadily growing at 2.5% per annum (Ambali *et al.*, 2011). The steady growth has on average been in terms of area, tonnage and yield of production (Table 17), though at a global level, total production has been quite modest, commanding only a 1.25% stake compared to 5.4% for Africa (FAO, 2010). That as may be the case as shown in Table 17, the region exhibits some of the highest above global average sugarcane yields, with countries such as Malawi, Tanzania and Zambia consistently reporting national average sugarcane yields of over 100 t/ha. In 2010, Malawi, Tanzania and Zambia registered 108.7, 119.6 and 105.2 t/ha respectively, against a world average of 70.8 t/ha and 60 t/ha for the RSA, the highest producer in Africa. Swaziland (96.2 t/ha), Zimbabwe (79.5 t/ha) and Mauritius (74.4 t/ha) similarly registered above average world yields (FAO, 2010). In addition to these high yields, there appears to be readily available and suitable land in the region for rain-fed sugarcane production. Watson (2011) calculates at least 6 million ha of such land in Angola, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe that would even trigger higher yields. All this points to the fact that the southern African region has huge potential for increased sugarcane production and its derivative bio-ethanol and signifies enormous potential for the expansion of the industry.

When compared with other regions in Africa, the southern African region has most of the highest sugarcane producing countries, at least 9 out of 12, each producing over 1.8 million tonnes per annum; with RSA being the highest producer with 19 million tonnes per annum (Figure 15). For bioethanol, many production plants in Africa are therefore found in SADC, with the most active leading countries being RSA, Malawi, Swaziland, Mauritius and Zimbabwe (FAO, 2015; HarvestChoice, 2015a,b). A number of important attributes account for this state of development. These include inherently good growing conditions for sugar cane (good soils; availability of supplementary irrigation; wet, hot summers for plant growth; cool, sunny, dry winters for conversion to sucrose) which produce high yields of sucrose per ha, typically over 1 t per month. The world average yield of sucrose from cane is around 0.5t per month (FAO, 2015).

Table 16: State of ethanol regulatory play in selected countries in SADC.

Country	Blend rate	Regulatory status
Malawi	20%	Possible 100% (with conversion units e.g., through Flex-fuel engine technology)
Mozambique	10%	• National policy and strategy • Investment criteria • Dedicated biofuels agency
RSA	2-10%	• No pricing framework agreed yet • 4c/l fuel levy announced • Biofuels Implementation Committee • National Strategy
Swaziland	10%	• National Biofuels Task Force • National strategy and action plan • Pricing model being finalised
Tanzania	Possible 10% blend by 2030	• National Biofuels Task Force • Investment criteria • Dedicated biofuels agency • Guidelines • Liquid Bioenergy Policy and Act being drafted
Zambia	Target for 10%	Not yet entered into force
Zimbabwe	(E15 – E20)5%	Possible 10% (E20 Mandatory since 2014, fluctuated to E15 due to insufficient supply)

Source: Brown, 2011; Braude 2013; ISO, 2013.

Table 17: **Sugar cane area, production and yield in southern Africa, 1992–2012**

	Harvested area			Cane production			Cane yield		
	('000 ha)			('000 t)			(t/ha)		
	1992	2002	2012	1992	2002	2012	1992	2002	2012
Malawi	18	24	27	1,900	2,600	2,800	105.6	108.3	103.7
Mozambique	15	35	46	159	1,586	3,394	10.6	45.3	73.9
South Africa	275	330	320	12,955	23,012	14,278	47.2	69.7	54.0
Swaziland	40	47	56	3,885	4,600	5,400	97.1	98.9	96.4
Tanzania	17	17	29	1,410	1,750	2,900	83.8	106.1	100.0
Zambia	14	22	39	1,300	2,300	3,900	96.3	104.5	100.0
Zimbabwe	14	40	45	125	4,200	3,700	8.9	105.0	82.2
Total	393	515	562	21,734	40,048	36,372	64.2	91.1	87.2

Source: (FAO, 2015)

Other attributes are the highly integrated nature of the agricultural sector in SADC, with sugarcane being perhaps the only SADC commodity group with a regional regulatory trade framework; the significant and well-established research and training capacity (the largest in the continent); and the existence of established access to finance (Braude, 2015). The accessibility to financing is largely due to the long-established, low cost sugar production levels that investors find most attractive. For example, in terms of cost per tonne of production, Chinsinga (2016) states that Malawi with a factory production cost of 7 US cents/lb, is the third most competitive producer in the world after Brazil (the world leading producer) and Zimbabwe, and putting it ahead of Zambia, Australia, RSA, Swaziland and Thailand. Thus, 5 of the lowest cost-effective sugarcane producing countries in the world are in southern Africa, with Zimbabwe, Malawi, Swaziland, Zambia, RSA, Mozambique and Tanzania topping the list (Chinsinga, 2016; Hess *et al*, 2016).

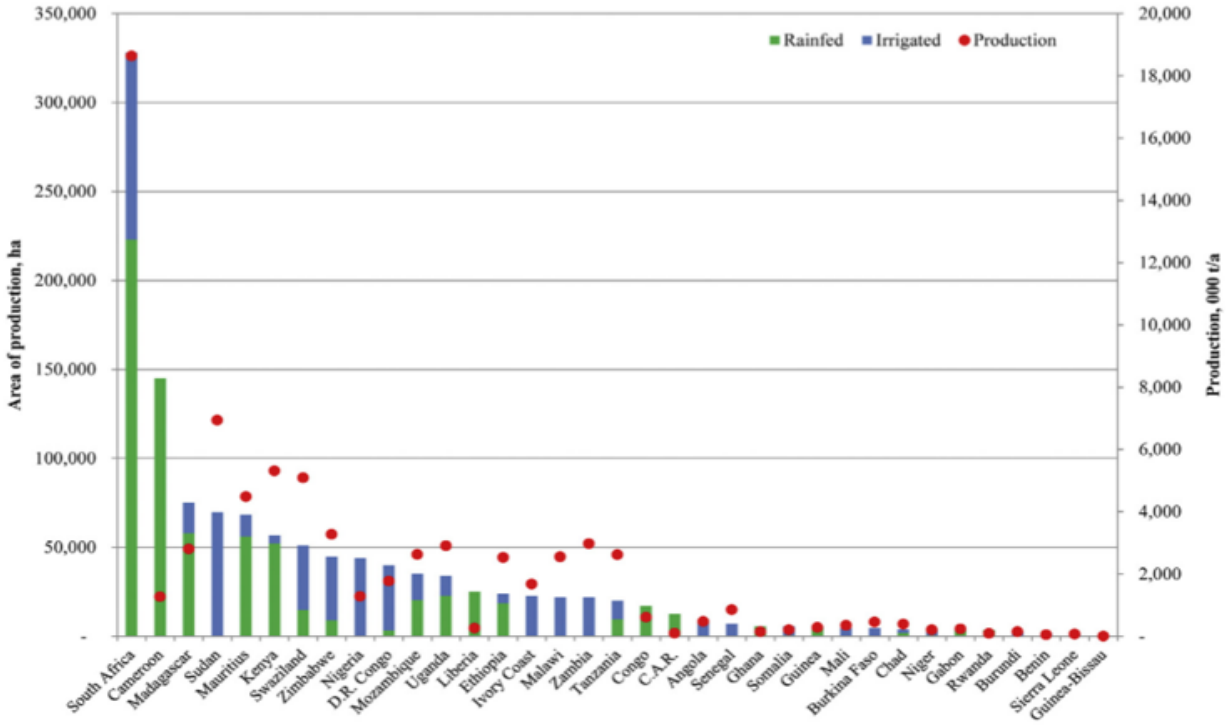


Figure 15: Sugarcane harvested area (ha) and average production (x 1000 t) by country in SSA (Source: HarvestChoice, 2015a, b; FAO, 2015)

A key factor in the sugarcane and bio-ethanol production systems is the involvement of smallholder farmers in large-scale plantations or small-scale out-grower farms or in a mix of both schemes. Though there is no “best” scheme as conditions must be considered on a case-by-case basis, the involvement of smallholder farmers as active partners appear to be more attuned than those based on large-scale plantations (Landell Mills Ltd., 2012). This study examined the involvement of smallholder farmers in sugarcane production by way of the out-grower scheme in order to determine their contribution to the growth and productivity of the sugarcane industry. This was done by analysing the data available for one study site, i.e. Dwangwa Sugar Estate, Malawi. Table 18 shows that in 2010 smallholder growers accounted for 45.5% and 34.5% of the total area of plantation and total sugar production respectively. This rose to 61% and 36.1% in 2015, representing within 5 years the smallholder growers’ increase in the Estate’s overall sugarcane plantation area and sugar production of 18.5% and 1.6% respectively. In this scheme, the involvement of smallholder farmers with support from government and the European Union (EU) aimed at empowering farmers to take sugar cane growing as a business and as a viable strategy for sustainable poverty reduction. This would in turn contribute to food security both by enabling farmers to grow food crops on the fringes of their irrigated sugar cane farms as well as providing increased incomes from sugar cane sales with which to purchase food.

Table 18: Contribution of smallholder farmers (Out-growers) to expansion of plantation area and sugar production in Dwangwa, Malawi.

Item	2010				2015				% Change in Out-grower share
	Sugar Estate	Out-growers	Total	Out-growers share (%)	Sugar Estate	Out-growers	Total	Out-growers share (%)	
Area of plantation (ha)	6,474.5	2,752.4	9,499.9	42.5	6,299.7	3,839.8	10,139.5	61.0	18.5
Sugar production (t)	724,591.0	255,886.4	980,477.4	34.5	686,666.3	247,782.8	934,449.1	36.1	1.6

A comparative study on incomes and poverty levels as a reflection of the socio-economic impact of the out-grower schemes was conducted in the same area by Herrmann and Grote (2015). With regard to increased incomes, this study shows that sugarcane out-growers had the highest per capita incomes which is more than twice the income of non-participants. Their average poverty rates were also significantly lower than those of non-participants (Table 19). In another study in Tanzania, participants similarly benefited considerably under similar out-grower arrangements referred to as best-practice cases in Tanzania (SAGCOT, 2013). A much earlier case study (Matango, 2006), similarly recorded of a successful sugarcane out-grower scheme operating in Kilombero and Mtibwa, owing largely to its effective organisation of growers through established associations.

Such positive outcomes however may not be universally applicable as there have been some cases in the region (e.g. Mozambique, Tanzania, Zimbabwe and Zambia) where out-growers appear to play only a marginal role in relation to the area and production of the estate, thus limiting the schemes poverty-reducing potentials and farmers negotiation power (Gibbon, 2011; Oya, 2012). Even in Malawi, for some of the smallholders who had been selectively incorporated into the out-grower production scheme, Chinsinga (2016) observed that they ended up being disappointed and disempowered. In this case, these smallholder farmers expressed losing their land completely; in others, even getting less land than they initially offered, ultimately losing control over how they use their own land. The net effect of this loss of land previously under forest cover or some food crop cultivation has been likened to fostering a process of disenfranchisement. Similar experiences in the region were recorded much earlier. For example, in Wami Basin, Tanzania, where farmers promised to benefit from the out-grower scheme appear to have ended up being evicted from their rice

production areas (Arvidson *et al.*, 2009). In terms of food security, promotion by the Swaziland government for the widespread adoption of sugarcane cultivation led to its complete dominance at the expense of food crops (FAO, 2008b), and land acquisition deals under the SEKAB project and Procana project in Tanzania (Sulle and Nelson, 2009) and Mozambique (Cotula *et al*, 2009; Vermeulen and Cotula, 2010; Borras Jr. *et al*, 2011) respectively, call into question the bargaining power of local land users, leading to people and land displacement. Thus, while there have been some positives in the region as observed above, there are still some underlying issues impacting on communities, the natural resource base and the environment that need to be thoroughly investigated to obtain fair and balanced assessments.

The actual case studies that might contribute to such balanced assessments, as observed by von Maltitz and Stafford (2011), may appear not to be many for the region and therefore limiting the full understanding of possible impacts and their unintended consequences. This study however gives summaries of identified impacts as revealed by stakeholders interviewed in the countries of study, together with impacts reported in a few previous regional studies (Table 20). In relation to agricultural land, land ownership and biodiversity, the summaries indicate that increased sugarcane production and therefore growth in bioethanol production appear to have reduced available land for crops, led to the displacement of people and deforestation, all seemingly contributing to food insecurity and loss of livelihoods. Though isolated to RSA and Mauritius, the indicated case studies also show that under increased sugarcane production, water resources and soils have attained hazardous levels of nutrient concentrations.

Table 19:**Comparative income and poverty levels of small-scale out-grower participants and non-participants in Dwangwa, Malawi**

Variable	Out-growers (n = 225)	Non-participants (n = 328)	Estate worker villages (n = 61)
Net farm income (MK)	591,573	63,357	33,208
Net non-farm income (MK)	124,357	71,654	104,390
House Hold (HH) annual income (net) (MK)	715,929	135,011	137,598
Per capita HH income/day (MK)	383	72	118

Variable	Out-growers (n = 225)	Non-participants (n = 328)	Estate worker villages (n = 61)
HHs below upper poverty line (%)	15	71	52
HHs below lower poverty line (%)	11	57	10

1US$= 730 MK (Malawi Kwacha)

Source: Partially extracted from Hermann and Grote, 2015.

Though the impacts highlighted in Table 20 may appear too few at a regional scale and therefore seemingly making any comprehensive, comparative analysis and extrapolation difficult, they serve to provide important lessons for the sugarcane industry. Thus, from the production activities and associated impacts, countries in the region can learn from each other's experiences and use the available evidence where relevant and possible to address concerns related to the sugarcane and biofuels production in their own countries. Though there is indeed every reason to believe that countries in the region operate at different production levels (Dubb *et al*., 2016), taking advantage of such evidence might help resolve some of the concerns for example those related to the out-grower schemes. Progressively, a gradual build-up of similar studies may lead to a comprehensive assessment of possible impacts and serve as a 'stitch in time' as projections at global aggregate level (and presumably related impacts) point to a four-fold increase in the production and use of biofuels from 2008 to 2035 (IEA, 2010).

Table 20: Summary of reported impacts associated with sugarcane production in southern Africa

Resource characteristic	Impact	Location	Source
Agricultural land	Reduced land for crops and therefore food insecurity	Madagascar Malawi Zambia Zimbabwe Tanzania Swaziland	Evident but unquantified Arvidson *et al* (2009) FAO (2008)
Land ownership	Displacement and affecting associated	Madagascar	

Resource characteristic	Impact	Location	Source
	livelihood strategies	Malawi Zambia Zimbabwe Tanzania Mozambique	Evident but unquantified Chinsinga (2016) Sulle and Nelson (2009), Arvidson *et al* (2009) Cotula et al. (2009), Vermeulen & Cotula (2010)' Borras Jr. *et al* (2011)
Biodiversity and forest cover	Deforestation, loss of forest dependent livelihoods	Madagascar Malawi Zambia	Evident but unquantified
Water sources	Increased nutrient concentration in runoff	RSA	Van der Laan *et al.* (2012)
Soil	Elevated phosphorus status	Mauritius	Mardamootoo *et al.* (2010, 2012, 2013)

4.4 INSTITUTIONAL ARRANGEMENTS FOR DEVELOPMENT OF BIOFUELS

In reflecting on the institutional arrangements governing the development of biofuels in countries in the region, it is important to establish the type of feedstocks used. The dominating primary feedstocks in the region are mainly jatropha (for biodiesel) and sugarcane (for bioethanol), with other feedstocks such as sorghum, soybeans, cottonseed and canola also receiving special attention (Table 21), even though their contribution is said to be much lower (Mitchell, 2011). The institutional arrangements for biofuels development are shown to vary between countries in the region but linked to similar production schemes. These generally relate to large-scale feedstock production in large plantations usually owned by foreign investors for commercial purposes, or produced by out-growers linked to large plantations or feedstock processing plants (von Maltitz *et al*., 2012). A common

feature is the use of 'outgrowers' in sugarcane production across the cases cited in Table 21, though the specific modalities of these arrangements are said to take on enormously varied forms across the region.

Various investigators in Malawi, RSA, Swaziland, Tanzania, Zambia and Zimbabwe for example Dubb *et al.* (2016) summarises these forms as ranging from small-scale plot holders in irrigated schemes such as in Malawi and Swaziland, to relatively larger-scale plot holders in the land reform areas of Zimbabwe. What is known though is that sugar cane production covers more than 0.5 million ha across the selected seven countries in southern Africa, and total cane harvested in the region has grown 80% over the past 20 years. Governments in the region supported by donors (e.g. the EU), view the sugarcane industry as a source of increasing direct employment, additional skills for modern agriculture and industry, augmenting tax base, raising scarce foreign reserves, forex savings and overall national development. The investments in sugarcane production are both domestic and foreign, but mostly driven by foreign, commercial investments by the RSA-based companies, e.g. Illovo and Tangaat Hulett with production capacity from the selected mills in Table 21 ranging from 300,000 to 3,000,000 t per annum. Overall, these two principal RSA sugar producers, plus TSB, thriving on favourable capital, domestic and foreign markets and overall operating profits, account for nearly 90% of the entire sugar output of the southern Africa region (i.e., 3.9 of 4.4 million t of raw sugar produced in the region) (Dubb *et al*., 2016).

Table 21 however shows that the majority of countries in southern Africa have been operating without the policies for promoting and regulating the development of biofuels. As observed by Mitchell (2011), this has been common in Africa, as the global interest from foreign investors for biofuel and feedstock production has caught most countries without the requisite, established policies. So far, the only countries in southern Africa to have formal biofuel policies in place include RSA (2007), Mozambique (2009) and Angola (2010) (von Maltitz *et al*., 2012). Countries in the process of developing the enabling policy and regulatory frameworks with draft policies having been drawn are Swaziland, Tanzania, Zambia and Zimbabwe, though the legislative processes are yet to be completed before enactment. The development and enactment of biofuel policies have certainly been at a much slower pace than those of the biofuel blending mandates (shown in Table 16), albeit the latter being binding and regulatory in nature. Given these mandates and in the absence of the specific biofuel policies, countries in the region have tended to be generally guided by relevant policies, mostly national energy policies and other regulatory instruments (Table 21). In addition, countries have tried to align themselves to the SADC regional level policy, legal and regulatory framework necessary for regional integration and sustainable production and use of biofuels.

The SADC Framework for Sustainable Biofuels and the SADC Biofuels Crop Decision Making tool, adopted in 2010 and assisted by FAO's Bioenergy and Food Security (BEFS)

initiative have enabled several SADC member states to draw up plans to encourage bioenergy development at the national level. This process designed to lead to the eventual development of national biofuels policies, strategies and guidelines was agreed by the SADC member state Energy Ministers (SADC, 2009). Through the FAO's BEFS initiative, policy makers have been assisted in being able to assess the interplay between natural resource availability, bioenergy production potential, rural development and food security and strengthen their capacity to manage trade-offs associated with bioenergy development. As an analytical tool, the BEFS initiative enables an analysis of likely bioenergy impacts on food security through competition for resources used in food production such as land, water and labour. It also enables analysis of the impact of bioenergy interventions on food security through changes in agricultural productivity, biomass utilization and other factors that influence food security, such as economic growth and employment (BEFS, 2012).

However, in spite of these regional initiatives, progress in developing national biofuel policies as noted above has generally been slow with lack of capacity and skills to develop national bioenergy plans cited as a major constraint. This slow progress was widely registered by stakeholders from governmental and non-governmental agencies in the energy sector across the study countries which they attributed to governance and institutional setbacks. The setbacks mentioned included the ineffectiveness of the national taskforces as part of the regional SADC Biofuels Taskforce and difficulties in getting the taskforces to meet to discuss and develop work plans mainly due to financial and human resource constraints. All stakeholders express the desire for the revival of the taskforces through commitments of more resources at the national level and the need to incorporate a wider range of stakeholders in the process.

Though there may be concerns on the impacts of sugarcane and associated ethanol production on environmental damage for example the high demand of sugarcane for water, often a more scarce resource for agriculture in southern Africa than land (Woodhouse, 2012, Hashem *et al*, 2015), the prevailing environmental and market conditions in southern Africa still possesses advantages in sugar cane production that make the region one of three or four 'low-cost' production centres in the world (Tyler, 2008; Dubb *et al*, 2016). Further, a number of issues were raised by stakeholders in the study countries that hold greater potential for enhanced development of the biofuel industry in the region. Paramount among them is the need for the development of a national biofuel policy, as lack of it constrains investment, the enabling diverse forms of production and profits, market opportunities, licensing, subsidies, labour issues that impinge on livelihoods particularly of out-growers, the clear and transparent government mandate and investment, tenure issues as they relate to access to land and other resources among others.

Overall, the above issues on policy were viewed together with a number of related institutional and governance concerns as fundamentally worth addressing for further development of biofuels (both liquid and solid). These were brought up with the realisation that countries in the region have some of the best plans to develop individual sectors including the biofuels sector, but that implementation is the major problem. By extension, policies and legislative instruments in the energy sector were largely regarded as comprehensively sound but that they face the same fate. The following is a brief summary of governance and institutional concerns:

(i) Change of governments and frequent cabinet reshuffles, resulting in lack of continuity in biofuels development and implementation of plans;

(ii) Political interference and conflict of interests;

(iii) Not well-co-ordinated, often conflicting institutions with different mandates, sectoral laws and policies that may directly or indirectly influence the biofuels sector;

(iv) Lack of mainstreaming into sectoral, institutional frameworks and therefore limited supportive environment towards biofuels;

(v) Absence of well-informed, science-based policy and decision making to stimulate the biofuels sector; and

(vi) Inadequate institutional capacity and awareness particularly on opportunities for small-scale out-grower schemes and initiatives on biofuels.

A profoundly articulated if not emotional concern expressed across the study countries related to the above concerns and to item 5 in particular, is the deep frustrations of professional foresters due to the widening policy-science interface divide. These frustrations are basically borne out of lack of policy direction and political will and therefore lack of implementation of science-generated results, an example of which is given in Box 2.

Table 21: Biofuels policy frameworks and level of investments in sugarcane production in selected southern African countries

Member State	National B/F Policy	Relevant Policy Instruments	Key (priority) feedstocks	Level of investment in sugarcane production			
				Foreign	Domestic	Mills	Production capacity (approx. tonnes/yr
Malawi	None	NEP, MERA	Sugarcane Jatropha	Illovo	DCGT, DCG	Dwangwa, Nchalo	300,000
Zambia	In process	NEP, Energy; B/F Industrial Strategy	Sugarcane Jatropha Sorghum	Illovo		Nakambala	400,000
Tanzania	In process	NEP; developing strategy	Sugarcane Jatropha	Illovo	Sukari Invest. Co. Tanzania Sugar Industries Ltd Kagera Sugar Ltd	Msolwa, Ruembe TPC (Moshi) Mtibwa Kagera	130,000 100,000 40,000 45,000
Mozambique	Yes	NBP (2009), Strategy; Regulatory framework; Inter-ministerial Task Team	Sugarcane Jatropha Sorghum	Illovo Tangaat Hulett	Tereos/Petrobras	Maragra Mafambisse, Xinavane Sena Sugar	84,000 250,000 100,000
Swaziland	In process	NEP, Renewable Action Plan	Sugarcane	Illovo Tangaat Hulett	Royal Swazi Royal Swazi Royal Swazi	Umbombo Mhlume Simunye	250,000 225,000 25,000
Zimbabwe	In process	White Paper on 'Principles of B/F Development & Use ((2007)'; Draft B/F Policy	Sugarcane Jatropha Sorghum Soybeans Cotton	Tangaat Hulett Green Fuels		Triangle, Hippo Valley Chisumbanje	600,000

Member State	National B/F Policy	Relevant Policy Instruments	Key (priority) feedstocks	Level of investment in sugarcane production			
				Foreign	Domestic	Mills	Production capacity (approx. tonnes/yr
			seed				
South Africa	Yes	NBP (2007), Renewable energy White Paper, B/F Industrial Strategy	Sugarcane Sunflower Canola Soybeans		Illovo Sugar Group Tongaat Hulett TSB Gledhow Sugar Co. Umfokolozi Sugar Union Cooperative Ltd.	Eston, Gledhow, Noodsberg, Sezela, Uzimkulu Amatikulu, Darnall, Maidstone. Komati, Malalane, Pongola. Gledhow Umfokolozi Dalton,	698,000 634,000 650,000 90,000 135,000 90,000

Source: Updated from Lerner and Motlhatlhedi (2010), Henley (2014), Dubb *et al* (2016) and stakeholder interviews.

Box 2: Sustainability challenges of wood production from lack of sustained science-policy interface

Back in the late 1970s the Forestry Department in Malawi, through its research scientists at the Forestry Research Institute of Malawi, conducted a country-wide fuelwood and polewood research project, with financial support from the Canadian International Development Research Council (IDRC). The research covering the whole country and whose trial plots were established on public, community and private lands across the country was designed to find the best-suited, fast growing tree species and provenances that would provide sustainable production and supply of fuelwood and poles; thereby averting the pressure of deforestation on indigenous forest resources. The research effort culminated late in 1980s in the identification of silvicultural zones of Malawi and the best-suited fast growing trees for each zone; amongst the top species being *Eucalyptus camaldulensis* and *E. tereticornis* (Hardcastle, 1978; Nkaonja, 1985). This led to perhaps the best afforestation drive in the country by both government, the private sector and individual households and greatly contributed to viable and sustainable wood production. After three decades and several rotations, due to lack of sustained political direction and will and the disconnect between science and policy, the vast areas of government fuelwood and polewood plantations are no longer productive. The resultant lack of support and adherence to prescribed rotational regimes have thus largely degraded the resource such that they can only supply small-sized stems that do not fulfil the original purpose for which they were established. This has pushed back the pressure onto the indigenous forests particularly forest reserves and the resultant impact of deforestation and unsustainable production is all too visible.

From this example and others from the study countries, there was a pressing call from stakeholders, mainly forestry professionals for the urgent need to develop programmes to resolve the ever-gaping science-policy divide in order for the countries and the southern African region to make progress towards viable and sustainable wood production. Alongside this call, it was proposed that countries in the region have a lot to learn from each other to harness the positive experiences and not 're-invent the wheel' for a viable wood industry.

4.5 STRATEGIES FOR DEVELOPMENT OF VIABLE BIOFUEL INDUSTRY

The assessments made in Section 3.4 on national and regional efforts for ensuring greater sustainability of a viable biofuels industry show the need for robust policies and regulatory frameworks, including improvements in production and consumption efficiency. This is

precisely because the problems identified in the biofuels sector rarely arise as a result of production alone but rather they are also a result of complex relationships between producers and consumers, the environment, and the larger political economy. All these must be considered when developing strategies for a viable biofuels industry, including paying attention to the underlying past and current development processes that cut across economic, energy, governance, forestry and probably cultural factors (NL Agency, 2010). In this section, experiences and practices on fuelwood from the southern African region and elsewhere in SSA are used to propose strategies for the development of a viable biofuels industry.

Although the bulk of firewood and charcoal production in the region is largely made from unsustainable sources in rural areas with the largest share of raw materials extracted from open miombo woodlands, forests and farm lands, strategic attempts have been made to try and attain production from sustainable sources. Though few in number, Table 22 highlights some of these. These include earlier attempts to produce charcoal from pine plantations in Malawi in the 1980s and from indigenous miombo woodlands in Zambia from the 1960s to the late 1990s by using the coupe system. However, such attempts could not be sustained due to lack of policy support and institutional arrangement changes in the Forestry Department in Zambia (Gumbo *et al*., 2013) and to product disintegration into charcoal dust in Malawi and therefore uneconomic. Similar difficulties as reported by the World Bank (2009a) have been experienced in other parts of SSA where attempts to bring about a sustainable and viable firewood and charcoal industry have more often than not resulted in failures. The underlying limitations have been both at technical and policy level, which fundamentally underscore the critical need to put in place robust policy and institutional frameworks and production efficiencies for a sustainable and viable charcoal industry.

Two examples from the region (i.e. Madagascar and RSA) and one from the central African region (i.e. Rwanda) however appear to have been based on strategies achieving long-lasting, sustainable impacts. The strategic interventions in Madagascar relate to individual, community and private reforestation schemes for charcoal production supported by the government. This is regarded as a promising strategic intervention guided by government policy, where tenure rights in respect of marginal public lands have been granted to individuals of local communities for the purpose of creating energy plantations. The village-based approach places local people at the centre of planning and implementation of plantation management for sustainable charcoal production. It is also based on voluntary participation of communities eager to rehabilitate degraded lands by means of voluntary reforestation using best practices of SFM (Ullenbreg, 2009; NL Agency, 2010). For monitoring purposes, agreed extraction rates including woody biomass must not exceed present growth rates. Using an integrated approach, new forest resources are created through reforestation of degraded landscapes with secure tenure rights; improvement of the entire wood fuel value chain; and establishing the conditions for an enabling framework.

Thus land rehabilitation is combined with local economic development to establish interconnected socio-economic impacts (diversification of income and increase of the landscape's production capacity); and environmental impacts (fire reduction, rehabilitation of degraded land and reduction of pressure on natural forests) (ETFRN News, 2014).

As a first step, an afforestation area is identified by the community and legally registered and a village-based participatory approval process allocates individual woodlots to interested households along with defined user rights and obligations. With technical support from government and NGOs, each plot is demarcated, mapped, and documented with the community's approval. Apart from the institutional and technical support thus provided, the nursery operations, planting, and maintenance are the plantation owners' responsibilities (NL Agency, 2010). An overall Geographic Information System (GIS)-based monitoring system provides data for every plantation plot, including productivity figures, income generated, etc. This approach allows increased annual planting and incomes for rural households, including those of the poorest and landless people, apart from substantially reducing the uncontrolled exploitation of natural forests in the vicinity of the villages and the incidence of fires (Sepp, 2008). In summary, the key elements of the individual reforestation scheme in Madagascar helped by the appropriate government policy and institutional provisions, strategically include limiting afforestation to marginal lands (with zero opportunity costs); voluntary decision of community members to participate; allocation of responsibilities to all community actors; individual ownership of plots and products (secured land/tenure rights); capacity building, creation of rural energy markets; and monitoring of plantation growth and quality.

Unlike in Madagascar, the main elements for charcoal production in the RSA are plantation-based schemes, mainly involving the private sector, include adherence to SFM of the well-established tree plantations; high level of organisation in the charcoal supply chain; good transport links with export markets; and relatively well-off middle-income charcoal users, as a ready domestic market. Together with the listed positive impacts (Table 22), the strategies adopted by Madagascar and the RSA signify an ever growing trajectory, away from government control, to empower rural communities and the private sector with the rights and responsibilities to manage local forest resources, and worth emulating by the other southern African countries.

Perhaps one of the best examples outside the region is the case of Rwanda, one of the few countries with increasing forest cover, growing about 7% from 2000 to 2005, primarily due to large numbers of forest plantations. Today, practically all charcoal in Rwanda is derived from trees that have been planted on government, private or community land. There are indications that private woodlots, using planted fast growing eucalyptus, are providing an increasing part of the firewood and charcoal market in Rwanda. As a result, charcoal production from natural forests is almost non-existent. Additionally, remnant rainforests are conserved by way of expanding the network of federally protected areas. Farmers have

become aware that with secure land tenure and rising wood fuel prices, it is profitable to invest in tree planting and to produce poles for construction, fuelwood and wood for charcoal making. Furthermore, due to rising income, the position and social standing of farmers in rural society has improved. Farmers are able to engage traders –who formerly held most of the power within the wood fuel value chain– on an equal footing, and to negotiate prices as is common in a free market economy (de Miranda *et al*., 2010; NL Agency, 2010).

Similar to Madagascar, one factor that has contributed to the success in Rwanda, is the issue of private land ownership on a large-scale and it may as well be the only country in Africa where the relation between charcoal and deforestation no longer exists. With this set up and as a result of allowing private land ownership, trees can be seen everywhere since people have an incentive to plant trees when they know that the tree will still be their property when it matures, which is not the case on common lands. In this regard, trees are a form of security for farmers which they can cash in case of need (MARGE, 2009b). The main strategic elements of the charcoal production system in Rwanda which the southern African countries can learn from include high timber and wood fuel prices due to massive prior deforestation; targeted efforts to conserve remnant rainforests; establishment of private plantations; secure land tenure; improved market control and negotiation power of farmers/ charcoal producers; and due to rising income and improved social standing of farmers in rural society.

One of the major lessons to be learnt from the above examples is that security of tenure (property rights) is a key policy and institutional factor that determines whether participatory forest management succeeds or fails - both from a forest management perspective and from the perspective of securing and maintaining participation over the long term (NL Agency, 2010). The participatory or community forestry model which has in its various forms been effectively used for sustainable and viable fuelwood and charcoal industry is coincidentally well-established in the southern African region through, for example, the work of the Centre for International Forestry Research (CIFOR) (Kajembe *et al*., 2003; Kayambazinthu *et al*., 2003; Taylor and Murphree, 2007). It remains an important strategic asset for the implementation of SFM and therefore for a sustainable and viable charcoal industry. In spite of this well-entrenched participatory, community forestry model for most of the study countries and the southern African region in general, centralised control and management of forest resources still drives the timber, firewood or charcoal extractive industries. This is against the backdrop of continued, unchecked harvesting of wood for charcoal without requisite replacement, with all the attendant problems associated with deforestation and forest degradation. Thus, in sharp contrast to the examples from Madagascar, RSA and Rwanda, and enabling legislative participatory frameworks and charcoal licensing provisions aside, countries such as Malawi and Zambia for example still apply sporadic, costly and in the long term, ineffective law enforcement operations to control

illegal charcoal production. It has now become the norm in Malawi for example to use the country's armed forces to control and clamp down illegal timber, firewood and charcoal extraction from plantations and forest reserves; the army being periodically deployed and camped in some of the hotspot forest reserves.

In summary, of strategies in Table 22 and views from the study countries, as well as those drawn from earlier investigations (e.g., Kambewa *et al*., 2007; Malimbwi *et al.*, 2007; Mutimba, 2007; NL Agency, 2010; Gumbo *et al*., 2013) for a viable charcoal and firewood industry, it would appear that the adoption of the following short and long term elements are central:

(i) Develop participatory woodfuel management and harvesting schemes and plans for forest areas at the local level based on SFM;

(ii) Secure forest tenure ("property rights"), a fundamental tenet for participatory management by granting exclusive control and right to produce and market wood-based fuels;

(iii) For marginal and/or degraded public forest areas, involvement of the private sector and local communities is a workable option, with potential to preserve/ameliorate land that would otherwise continue to remain idle, unproductive and continually degrade;

(iv) Set up management plans for restoring public national and local plantations, develop and promote tree management and rational cutting methods, train local bodies and professionals on SFM; and

(v) Develop and promote silvicultural practices among private plantation owners in order to preserve and improve their standing stock and increase forestry productivity for a sustainable industry.

Table 22: Strategies for viable biofuels industry in selected countries

Country	Production system	Strategic system change/value addition	Source
Madagascar	Government/community/private woodlots and plantations; Appropriate government policy and institutional provisions; Provision of technical, monitoring and advisory services on plantation growth and quality to communities	Tenure rights of marginal public lands granted to individuals of local communities to create energy plantations; Use of best practices of SFM; Use of integrated reforestation of degraded landscapes with secure tenure rights, improved wood fuel value chain and conditions for	Ullenberg, (2009); NL Agency (2010); ETFRN News (2014)

Country	Production system	Strategic system change/value addition	Source
		enabling environment; Village-based approach of community planning and management for sustainable charcoal production; Voluntary participation of communities eager to rehabilitate degraded lands, i.e., voluntary reforestation; Middle income charcoal users. ***Impact*** Creation of energy plantations; Increased production of sustainable charcoal; Reforestation of degraded lands; Communities at the centre of planning and implementation of plantation management for sustainable charcoal production; Inculcated spirit of community commitment through voluntary participation.	
RSA	Private sector plantations (primarily for pulp, wattle extract and timber).	Less government control and empowerment of private sector and rural communities; Adherence to SFM (silvicultural prescriptions); High level organisation in supply chain; Good transport links to markets; Middle income charcoal users. ***Impact*** Enhanced high level supply chain; Highly empowered private sector and communities; Increased production of sustainable charcoal; Increased charcoal markets, both domestic and foreign; Enhanced value-addition to plantation wood and waste.	NL Agency (2010) citing Stassen, 2010; pers. comm.

Country	Production system	Strategic system change/value addition	Source
Rwanda	Government, private sector, communal land woodlots and plantations	Secure land tenure; Application of private land ownership on large scale; Improved market control and negotiation power of farmers/charcoal producers; High timber and woodfuel prices due to massive prior deforestation; Use of fast growing eucalypts. ***Impact***: Charcoal production and deforestation no longer exists; Expansion of protected forests; Farmers secured on land tenure; Rising income, improved social standing of farmers; Farmer empowerment.	de Miranda *et al* (2010)
Malawi	Government pine plantation Private sector plantation for lemon eucalyptus oil extraction and timber (with charcoal as a by-product)	Technical limitations resulting in poor quality charcoal; Limited market opportunities; No involvement of private sector and communities; Operated in an environment of inaccessible production licences to private sector and communities, hence illegal production. ***Impact*** Discontinued; uneconomic and therefore unsustainable; Sustainable charcoal as a by-product; Use of fast growing eucalypts under SFM; Produced under license. ***Impact***	

Country	Production system	Strategic system change/value addition	Source
		Reforestation; Enhanced revenues and community incomes.	
Zambia	Indigenous woodlands, Government/private sector	Sustainable charcoal using 'coupe' system; Lack of policy support; Institutional challenges due to changes in organisation. ***Impac***t Discontinued; unsustainable.	Gumbo *et al.* (2013)

The strategic repositioning, encapsulated in the above outlined entreaties requires governments in southern Africa to take bold steps to address them, particularly as a lot of time has passed without substantive progress since these were made by earlier investigators. This is even more urgent today, when policy options are now being promulgated for climate-smart biofuels production for mitigating climate change and improving livelihoods. In this regard, FAO (2013, 2017) emphasises, much as has been observed above, the need to address a suit of policy, legal, institutional and regulatory frameworks; planning and decision-making processes and implementation; enforcement and compliance.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The report has outlined the rich natural resource base that the countries under study and the southern African region have and the existing potential towards contributing to their social economic growth and development. The extractive industries, apart from being seen as contributing effectively to such growth and development, must be responsibly managed, guided by robust policies and institutional frameworks. Such framework would help to avoid adversely impacting the sustainable production of food, fibre and biofuels and negatively influencing the competition thereof and at the same time avoid leaving negative and heavy climatic, environmental and social footprints, of which there have been all too many and devastating in recent times.

Trends in forest cover change

Forest cover change was analysed for a few selected miombo woodland hotspots and the southern African region as a whole. The rate of deforestation has been shown as slowing down overall though the general decline in forest cover in terms of the overall loss of forest cover still remains alarmingly high. Except for countries with no deforestation (e.g. Swaziland) or minimal deforestation (e.g. Lesotho, Mauritius, Seychelles and RSA), the region is largely characterised by an ever-changing forest landscape without a steady trajectory towards continued reduction of forest loss. For example, the deforestation rates more than doubled between 2005 and 2012 for Malawi and Zambia to reach 2.4% per annum, the highest in the region, while the average increase was 0.46% for the region as a whole. These figures signify that regardless of disparities in rates of deforestation, there has been and continues to be on average a downward trend in forest cover nationally and regionally, representing a continued loss of forest goods and services and thereby reduced opportunities for national and regional socio-economic development. The main drivers of deforestation across the region have been identified and include conversion from forest land to crop land, a high dependence on wood as an energy source, unsustainable logging practices and infrastructural development, among others. These drivers have been observed not to act alone as forest cover change is compounded by a number of other drivers, policy and legislative in nature; yet others have been linked to problems of land availability, poverty and drought, among others.

From a policy and legislative perspective, the attempts made to address the drivers and reverse the impacts of deforestation and land degradation have been through the SADC Forestry protocol at the regional level and a number of related policies and legal frameworks at the national level. All these have been designed to promote reforestation and afforestation programmes; use and application of renewable energy technologies to reduce dependency on wood and charcoal; and regional veld and forest fire prevention programmes. The policy and legislative instruments have been evolving across the region to deal with old and new, underlying causes of deforestation and these are at various stages of development. For example, across the four study countries, these have either been in the process of formulation and development (e.g. Zimbabwe), review (e.g. Madagascar) or reviewed and recently enacted (e.g. Malawi and Zambia). Though impacts of the recently enacted forestry polices in Malawi and Zambia are yet to be seen (and must therefore be monitored), overall enactment of past policies in the region have invariably been characterized by widespread failure in terms of implementation and enforcement thus indirectly contributing to deforestation and subsequent forest decline. A number of reasons were identified as contributing to this scenario, among which are lack of political will, political interference, vested interests and corruption, agricultural subsidies (indirectly promoting decimation of forests through encroachments), low levels of government support and therefore weak implementing institutions, independent and uncoordinated operations of sectors and therefore lack of synergies, overriding policies such as those on mining over forestry, and inconsistencies in both policy and legislation.

Extractive industries and impacts

Timber, mining and fuelwood extractive industries have been analysed to cause quite a varied array of impacts, such as clearing of large tracts of natural forests, loss of forest resources resulting in reduced wood and fuelwood availability, among others. In the case of mining, apart from identified operational activities, its superior hierarchical position and top priority in government legislation over and above other sectors, like forestry, has led to massive loss of forests. A contributing factor has been the degree of coordination and harmonization of policies and legislation across interlinked sectors (e.g. mining and forestry), which has been revealed as very poor. Whether or not such policy and legislative restrictions are the reason why studies have not yet been commissioned to directly link mining to deforestation, emissions and climate change is an issue which this study was not able to establish but all the same worth investigating.

The high dependence of predominantly poor urban to peri-urban households on charcoal and firewood, fuelling the ever-increasing loss of forest cover, as the main source of energy has been attributed to the fact that these sources of energy are relatively cheaper when compared with electricity and petroleum-based fuels. The continued dependence and growth in urban demand for this form of energy can be likened to a double-edged sword. On one hand, the impetus for increased production, consumption and commercialisation has

had a knock-on effect of contributing to growth of national economies, averaging about 3.0% for the region through increased household incomes, tax revenues and employment along its value chain. On the other hand, the region continues to lose forests, largely through the unsustainable production and extraction of fuelwood.

The analysis on charcoal and firewood production and consumption reinforces and gives evidence of a defining future of continued dependence on charcoal as a major form of energy in southern Africa. Clearly, the high levels of consumption plus the high population growth and increased urbanisation can only lead to greater demand, implying increased production and consumption. A comparative analysis of the magnitude of increased annual consumption across Africa has revealed that southern Africa may well be the region on the continent with the most serious challenge in how to meet growing consumption levels from existing resources. The challenges facing the region in meeting the growing demand have been reviewed to include weak, misguided, neglected, underdeveloped, disjointed, overly prohibitive, contradictory or non-existent policies and laws, combined with poor enforcement and regulatory capacity of the fuelwood industry.

The associated challenges facing the region have been analysed in terms of the extent to which fuelwood production may be linked to GHG emissions and attendant environmental and climate change problems. When average total GHG emissions, juxtaposed against deforestation rates for countries with the same miombo woodland vegetation, namely Malawi, Zambia and Zimbabwe, a general incremental relationship though different in magnitude was apparent. Overall, the levels of GHG emissions generally increased with increased deforestation rates. Consistent with previous findings, this affirms the fact that charcoal and firewood production contribute to the release of harmful GHG into the atmosphere. Though only contributing about 2.29% to the overall global GHG emissions with relatively lower percentage contributions from individual countries (between 0.01-0.18%; except for RSA with 1.46%), the unsustainable production and consumption levels of charcoal and firewood are therefore of major concern for the region.

Additionally, the challenges related to unsustainable charcoal and fuelwood production and use in the region have led to attempts to find suitable and sustainable alternatives, to migrate from use of biomass fuels to modern cleaner forms within a country's energy mix (e.g. petroleum-based alternatives (LPG and kerosene) and electricity). However, the issue of accessibility and affordability has been identified to force people to continually depend on charcoal and firewood. Malawi, Zambia and Zimbabwe appear to show a continued upward surge in electricity tariffs which is consistent with increased rates of deforestation and emissions. This confirms that as long as electricity tariffs keep increasing beyond affordability for most people, continued and unsustainable production and consumption of wood fuels would be the order of the day into the foreseeable future. Compounding the issue of affordability for countries in the region, except for Namibia and Tanzania (reported to have already achieved cost reflective tariffs), is the challenge that generally manifests

itself in power deficits leading to load shedding, higher system losses and failure to attract investment. These have been observed as neither helping reduce nor replace the present and future dependence on firewood and charcoal as a major source of energy. In fact, taken together the combination of continuing growth in urban charcoal demand with rapid population growth, urbanization and increasing costs of alternative fuels including electricity affirms the dominance of charcoal in the energy mix of the region in the foreseeable future.

In an examination of the status of existing policy frameworks, approaches and reforms related to charcoal, wide diversity exists between countries ranging from centralised and restrictive (e.g. in Tanzania and prior to enactment of new policies in Malawi and Zambia) to decentralised, innovative approaches (e.g., in Madagascar and RSA). The restrictions characterised by the former approaches have proved counterproductive, further pushed the illegal activities underground, lead to loss of government revenue, uncontrolled environmental degradation and to increased levels of unsustainable production. The latter approaches have led to the adoption of innovative, decentralised sustainable charcoal production systems, where secure tenure rights are granted to individuals, households and the private sector through SFM afforestation/reforestation programme. Similar approaches have been cited for some communities in Tanzania. In these approaches, an integrated policy framework is advocated involving many sectors including energy, forestry, agriculture, transport, and even health in order to have a comprehensive approach that takes care of the entire charcoal value chain.

In spite of some limitations, which have been highlighted, in the production and consumption of timber (e.g. forest plantations accounting for only 1% of total forest cover, huge disparities in the extent and distribution of forest resources, lack of availability of suitable land, among others), the region is shown to have in recent times achieved some positive growth in the production of industrial round wood and sawn wood which have steadily grown at an average of 2.3% and 1.7% per annum respectively. This signifies an active and growing rather than dormant timber industry. The regional outlook on trade has been that of increasing sawn wood exports (by 1.9%) and imports of industrial round wood (by 18.1%) with the magnitude of the traded sawn wood volumes being much greater (i.e. more than treble). Such increased production levels combined with readily available continental and global markets (not least the booming Chinese economy which requires massive amounts of raw materials for their bourgeoning housing construction and furniture industries) have been deemed as providing trade opportunities for the development of the enabling trade policy framework for the region.

Competition on biofuel production on food production, land security and biodiversity habitat

Apart from some jatropha production initiatives in the region shown to have lost investors due to the emerging food-vs-fuel and land-grabbing competition (e.g. in Mozambique),

notable projects from BERL (Malawi) and Niqel (Mozambique) appear to provide viable options in addressing the concern of competition for land with agricultural crops. BERL's project analysed in this study based on small areas for hedgerow planting by smallholder farmers in predominantly high food insecurity areas affords farmers to generate additional income, enabling poor households purchase food during the 'lean' most food insecure period of the year. Thus, the 'safety net' provided by this approach has had a positive impact on food security to the farmers. For the time being, there seems to be no known evidence of the competition between jatropha cultivation and food crop production.

Reviewed studies from the southern African countries (e.g., Angola, DRC, Mozambique, Tanzania, Zambia and Zimbabwe) have shown the region to have abundant land such that production of energy crops is assumed not likely to disturb food production. However, for some of these countries (e.g. Madagascar, Malawi, Zambia and others), the competition for land with food crops and issues surrounding land security and biodiversity habitat require further investigation. The government of Zambia for example being aware of the controversy of land versus food security, has rather been lukewarm in committing effort and investment in the production of jatropha. In most cases nevertheless what appears to be the major argument is that biofuels require large tracts of land to produce feedstock hence they are perceived as an emerging driver of habitat alteration, biodiversity loss, food insecurity and community displacement and disenfranchisement.

In the case of bio-ethanol, produced from sugarcane molasses under a regionally well-established and competitive sugarcane industry steadily growing at 2.5% per annum, a key factor of production is the involvement of smallholder farmers in large-scale plantations or small-scale out-grower farms or in a mix of both schemes. As a strategy, this approach aimed at empowering farmers to take sugar cane growing as a business and as a viable strategy is shown to contribute towards poverty reduction and in turn to food security. This is premised on farmers growing food crops on the fringes of their irrigated sugar cane farms as well as providing increased incomes from sugar cane sales with which to purchase food. This may not however be universally applicable in the region as there have been some cases (e.g. in Mozambique, Tanzania, Zimbabwe and Zambia) where out-growers appear to have experienced loss of land previously under forest cover or some food crop cultivation to sugarcane growing, likened to fostering a process of disenfranchisement. In terms of food security, promotion by the Swaziland government for the widespread adoption of sugarcane cultivation led to its complete dominance at the expense of food crops and land acquisition. Similarly, the SEKAB and Procana projects in Tanzania and Mozambique respectively led to people and land displacement. A summary of other studies done in the region in relation to agricultural land, land ownership and biodiversity, indicate that increased sugarcane production and therefore growth in bioethanol production appear to have reduced available land for crops, attainment of hazardous levels of water resources and soils, led to the displacement of people and deforestation, all seemingly contributing to food insecurity and

loss of livelihoods. Viewed together, there seems to be a mixed bag of the types and nature of competition for food, land and biodiversity habitat from biofuels production in the region. Clearly, there are still some underlying issues, under different community, natural resource base and environmental contexts that need to be thoroughly investigated to obtain a comprehensive, fair and balanced assessments on the nature and magnitude of the competition.

Policy frameworks and approaches incentivising sustainable fuelwood production

There have been major policy shifts in approaches towards addressing fuelwood challenges (e.g. enacted in Malawi 2016 Forestry Policy and Zambia 2014 Forestry Policy), away from the centralised and restrictive policy frameworks to incentivising participatory approaches. This has been done by embracing the building blocks for sustainable charcoal production by first recognising for example the inadequate supply of electricity, LPG and/or biogas, the increasing fuelwood demand exacerbating the already high deforestation rates and climate change. A multi-sectoral approach of all stakeholders in the value chain has become the centre-piece for effective implementation of the new policies by utilizing sustainable charcoal production principles under SFM. Since these policies have just been enacted, it would be important to monitor their impact and the extent to which the two countries share experiences and learn from each other going forward for the benefit of countries in the region.

Namibia and RSA have been shown as countries with valuable experience in commercial charcoal production worth sharing with the countries in the region on developing a sound fuelwood policy framework. They exemplify innovative approaches of using a by-product of cleared invader bush to develop a thriving charcoal industry (in Namibia) and organized commercial plantation charcoal production (in South Africa). The policy created in terms of formal and international trade in wood energy is worth emulating and demonstrates the existence of and potential for cross-border trade in charcoal between countries in southern Africa, which has increasingly become an important socio-economic commodity that it can no longer remain in the informal sector.

Institutional Arrangements and Policies for Development of Biofuels

The institutional arrangements for biofuels development have been shown to vary between countries in the region but linked to similar production schemes. These generally relate to large-scale feedstock production in large plantations usually owned by foreign investors for commercial purposes, or produced by out-growers linked to large plantations or feedstock processing plants. A common feature is the use of smallholder farmers or ‘out-growers’ though the specific modalities of these arrangements are noted to take on varied forms across the region.

Government policy and institutional support is key to existing biofuel production schemes in the region, essentially by providing a conducive environment for investments. So far the only countries in southern Africa to have formal biofuel policies in place are the RSA (2007), Mozambique (2009) and Angola (2010), while the majority of countries have either drawn draft policies (Swaziland, Tanzania, Zambia and Zimbabwe) or are in the process of developing the enabling policy and regulatory framework. This implies that the majority of countries have been operating without policies for promoting and regulating the development of biofuels. Progress so far indicates that the development and enactment of biofuel policies have certainly been at a much slower pace than those of the biofuel blending mandates. The major constraints for the slow progress has been attributed to lack of capacity and skills to develop national bioenergy plans, governance and institutional setbacks, including the ineffectiveness of the national taskforces as part of the regional SADC Biofuels Taskforce and difficulties in getting the taskforces to meet to discuss and develop work plans mainly due to financial and human resource constraints have been some of the underlying factors.

In the absence of specific biofuel policies, an institutional prerequisite for development of biofuels, countries in the region have tended to be generally guided by other relevant policies, mostly national energy policies and other regulatory frameworks guided by the SADC, regional level policy, legal and regulatory framework necessary for regional integration and sustainable production and use of biofuels. The SADC Framework for Sustainable Biofuels and the SADC Biofuels Crop Decision Making tool adopted in 2010 and assisted by FAO's BEFS initiative, serve as the most important guiding institutional arrangements. These have aided member states in drawing up plans to encourage bioenergy development at the national level, a process which will lead to the eventual development of national biofuels policies, strategies and guidelines.

Overall, a set of institutional and governance concerns were identified as fundamentally worth addressing for the development of a viable biofuels industry both at country and regional levels and these include:

i. Change of governments and frequent cabinet reshuffles, resulting in lack of continuity in biofuels development and implementation of plans;

ii. Political interference and conflict of interests;

iii. Not well-co-ordinated, often conflicting institutions with different mandates, sectoral laws and policies that may directly or indirectly influence the biofuels sector;

iv. Lack of mainstreaming into sectoral, institutional frameworks and therefore limited supportive environment towards biofuels;

v. Absence of well-informed, science-based policy and decision making to stimulate the biofuels sector; and

vi. Inadequate institutional capacity and awareness, particularly on opportunities for small-scale, out-grower schemes and initiatives on biofuels.

Item v) was one of the most profoundly articulated concerns expressed across the study countries, with professional foresters widely frustrated by the widening policy-science interface divide, basically borne out of lack of policy direction and political will and, therefore, lack of implementation of science-generated results.

Strategies for tracking changes in levels of production and consumption of fuel wood

Experiences and practices from countries in the region and elsewhere in SSA have been used to propose strategies for tracking changes of monitoring the production and consumption of fuelwood. Placing local people at the centre of planning, monitoring and implementation of plantation management for sustainable fuelwood production using best practices of SFM as demonstrated through projects in Madagascar, South Africa and Rwanda, proposes a long-lasting strategy for tracking the changes. This entails for example that agreed extraction rates including woody biomass must not exceed present growth rates. Using an integrated approach involving communities (demonstrated in Madagascar and Rwanda) as a first step in the monitoring process, an afforestation area is identified by the community and legally registered and a village-based participatory approval process allocates individual woodlots to interested households along with defined user rights and obligations as a basis for monitoring.

Technical support from government and NGOs is critical, as each plot is demarcated, mapped, and documented with the community's approval. An overall GIS-based monitoring system provides data for every plantation plot, including productivity figures, income generated, etc. This monitoring approach allows increased annual planting and incomes for community households to be recorded and used to track progress.

The main elements for tracking charcoal production in the RSA, based on plantation schemes include adherence to SFM of the well-established tree plantations; high level of organisation in the charcoal supply chain; good transport links with export markets; and relatively well-off middle-income charcoal users, as a ready domestic market. Outside the region, the case of Rwanda has been discussed as providing a robust monitoring system for the production and trade of charcoal based on trees planted and assessed on government, private or community land through demarcated woodlots. Even for fast growing eucalyptus, such an assessment for monitoring purposes makes it easily profitable to invest in tree planting and to produce poles for construction, fuelwood and wood for charcoal making.

Such quantified resources makes farmers able to engage with traders on an equal footing and to negotiate prices as is common in a free market economy.

All the above participatory or community forestry models which have effectively been used for tracking a viable and sustainable fuelwood industry is coincidentally shown to be well-established in the southern African region. Though most of the study countries in the region have in general centralised control and management of forest resources driving the timber and fuelwood extractive industries, these models still remain strategically important for the implementation of SFM of fuelwood.

In summary, the following short and long-term strategies have been recognised as critical:

a) Develop participatory woodfuel management and harvesting schemes and plans for forest areas at the local level based on SFM;

b) Secure forest tenure ("property rights"), a fundamental tenet for participatory management by granting exclusive control and right to produce and market wood-based fuels;

c) For marginal and/or degraded public forest areas, involvement of the private sector and local communities is a workable option with potential to preserve/ameliorate land that would otherwise continue to remain idle, unproductive and continually degraded;

d) Set up management plans for restoring public national and local plantations, develop and promote tree management and rational cutting methods, train local bodies and professionals on SFM; and

e) Develop and promote silvicultural practices among private plantation owners, in order to preserve and improve their standing stock, and increase forestry productivity for a sustainable industry.

5.2 RECOMMENDATIONS

The following are the key recommendations:

i. Faced with declining forest resources, competition from the mining sector and between food, fibre and energy needs, the growing energy demands and associated GHG emissions, the region must promote the development of harmonised policies and regulatory frameworks for formal trade and investments in renewable energy, energy conservation and energy efficiency critical in reversing the trends in forest loss. This entails, for example, promoting research and development, mainstreaming of climate change into mining operations, strengthening regional integration in planning and development of renewable energy, including communication and

information sharing on renewable energy technologies and enhanced energy infrastructure development.

ii. In addressing concerns in the biofuels sector, particularly those linked to some of the reported competition and associated impacts on food, land and biodiversity, countries in the region must learn from each other's experiences and use the available evidence where relevant to address such concerns. Though there is indeed every reason to believe that countries in the region operate at different production levels, taking advantage of such evidence might help resolve some of the concerns, for example those related to the out-grower schemes. Progressively, a gradual build-up of similar studies (which must be encouraged) may lead to a comprehensive assessment of possible impacts and serve as a 'stitch in time', particularly when projections of the production and use of biofuels (and presumably related impacts) at global aggregate level point to a four-fold increase by 2035.

iii. Further studies are needed especially on lesser known feedstocks and the ecological requirements to improve raw material production, as well as investing in their further processing; not overlooking how biofuel production competes with other land uses. With respect to firewood and charcoal, there is a need to develop legally organised sustainable production and marketing systems that will effectively incentivise the actors in this industry in the context of climate change and other emerging issues.

iv. To overcome low levels of timber production and trade in for example round wood and sawn wood, countries need to make substantial progress in trade commensurate with the available resources by significantly increasing investments or reinvestments and improving capacities in forest production, while at the same time overcoming a number of infrastructural, institutional and governance limitations. This requires concerted efforts by countries in the region, drawing on the success of other countries in the region in wood and wood products e.g. the RSA and Swaziland, through exchange and transfer of technologies and expertise for greater inter-regional integration through SADC and COMESA.

v. The region needs to revisit the charcoal production value chain at policy and practice levels in an integrated manner with the explicit purpose to incorporate an inter-sectoral approach and avoid sectors that directly or indirectly influence SFM and charcoal production working in isolation to one another. Given the sectors involved in the whole value chain, there is need for integrated formulation of policies which should also provide for the effective regulation of the fuel sector through the continuous monitoring of activities of the charcoal industry in relation to prices, trends, and volumes of production and consumption levels.

vi. Existing trade agreements between countries mainly under the coordination of SADC and COMESA must incorporate charcoal production and trade, become part of the normal, formal trade between countries in order to move away from the largely informal trade which retards regional efforts for coordinated SFM and compromises efforts in reducing deforestation and forest degradation, curbing environmental degradation and reducing impacts of climate change. The enabling framework that should drive the commitment towards such a paradigm shift should draw on the positive experiences from Madagascar, Namibia and the RSA, and other countries in SSA such as Rwanda, provided there is willingness between countries under the guidance of SADC and COMESA to learn from one another. These would essentially lead the region to minimise forest losses, develop and implement sustainable methods of extraction and utilization of wood fuels by improving efficiency technologies, encourage use of alternative energy sources and use of plantation species in charcoal production.

vii. Countries in the region must urgently develop programmes to resolve the ever-growing science-policy divide in order for the region and countries in the region to make progress towards viable and sustainable wood production. In this regard, countries in the region have a lot to learn from each other to harness the positive experiences and not 're-invent the wheel' for a viable wood industry. Priority must therefore be given to capacity building of institutions in biofuel initiatives across the value chain. In a similar vein, it is highly recommended therefore that bioenergy policies and institutional frameworks be developed, informed by rigorous, science-based and research-generated information. To this extent, AFF and other development-oriented regional institutions must develop mechanisms for spearheading programmes designed to narrow the science-policy gap, to maximise the use of professionally-generated information, for maximum returns on investments both in terms of research and capacity building for enhanced food-fibre-fuel production.

viii. Though dominated by the RSA, the intra-regional trade (of processed forest products, mostly paper, plywood and fibreboards, furniture, doors, fittings and joinery) is highest in the region compared to the other African RECs. However, trade with the rest of Africa has hitherto been regarded as the lowest and efforts must therefore be made to improve this trade as well as with the world at large. Indeed while this trade is regarded as improving and more important for the sub-region, it remains insignificant in global terms, with total trade volume representing only around 1% of total world trade.

ix. Southern Africa must develop new production and trade strategies to improve intra-African and regional trade by addressing governance, including policy and institutional factors, which are claimed to be primarily responsible for causing poor management of the timber industry, leading to further deforestation and forest degradation. The main concerns have been lack of clear policies related to the timber industry, unresolved issues of equitable and secure timber rights; vested interests; policies focusing largely on economic growth generated by industrial development at the expense of sustainable timber production; weak and non-integrated sector policies impinging on the timber sector; policies addressing different environmental aspects often not coordinated; weak and centralized regulatory systems.

x. There is need for closer cooperation within and between RECs such as CEMAC, COMESA, EAC, ECOWAS, SACU, SADC and WAEMU for enhanced integration in timber production and trade in the continent and regionally preferably under the trade areas TFTA and CFTA which are designed to spur intra-regional trade and investment. This would also enable Africa to overcome limitations of too many small and fragmented markets, the huge differences within and between regions, the varied limited levels of trade integration within economic zones, the lack of economic diversification necessary to achieve the economies of scale necessary to compete internationally and in the continent.

xi. National Biofuels Taskforces, being part of the regional SADC Biofuels Taskforce must be revived or reinvigorated through commitment of more resources at the national level and incorporation of a wider range of stakeholders in the process. This, plus the need for the development of a national biofuel policy holds greater potential for enhanced development of the biofuel industry in the region. Active taskforces are key to expediting the development of work plans, agreed at SADC level, the national biofuel policies and cushioning against lack of continuity and implementation of national programmes that come with change of governments and frequent cabinet reshuffles, political interference and conflict of or vested interests, among other identified conflicts.

xii. Participatory or community forestry approaches well-established in the region must be used to effectively track changes in the levels of fuelwood production and consumption. These approaches still remain strategically important for the implementation of SFM of fuelwood in the region. The adoption of these approaches will also help the region move away from the centralised control and management of forest resources. To this extent, the new approaches and relevant policies must be monitored and countries must share experiences and learn from each other.

xiii. In summary, the following short and long term strategies have been recognised as important building blocks for tracking sustainable production and consumption of fuelwood for the region:

- Develop participatory wood fuel management and harvesting schemes and plans for forest areas at the local level based on SFM;
- Secure forest tenure ("property rights"), a fundamental tenet for participatory management by granting exclusive control and right to produce and market wood-based fuels;
- For marginal and/or degraded public forest areas, involvement of the private sector and local communities as a workable option, with potential to ameliorate land that would otherwise continue to remain idle, unproductive and continually degraded;
- Set up management plans for restoring public national and local plantations, develop and promote tree management and rational cutting methods, train local bodies and professionals on SFM; and
- Develop and promote silvicultural practices among private plantation owners, in order to improve their standing stock and increase forestry productivity for a sustainable industry.

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APPENDICES

APPENDIX I: METHODOLOGIES IN ADDRESSING KEY RESULT AREAS TAKING INTO CONSIDERATION TYPES OF DATA COLLECTED AND SOURCES

Key result area	Type of data	Data collection procedure	Data Sources
KR1: Assess trends in forest cover change in selected hotspot areas of respective country and sub regions	• Types of forest • Deforestation and reforestation rates in general and specific forest types for selected countries • Land use and change • Drivers of forest cover change (population, level of income, poverty level, technology, climate change, etc)	Secondary data Interviews with relevant stakeholders	FAO State of the World Forest Forest Resources Assessment Publications from IUCN,WRI, WWF, AFF, IIED, IUFRO, CIFOR, ICRAF, etc. Publications from MDAs in the selected countries, SADC Secretariat Publications from other development organizations.
KR2: Assess and document impact of extractive industries (timber, mining, charcoal making, etc.) on the 3Fs in the context of climate change	• Types and trends of extractive industries (logging, mining and charcoal production, petroleum, fuelwood, etc.) • Trends in the 3Fs • Effects of extractive industries (logging, mining, charcoal production) on 3Fs in context of climate change.	Secondary data Interviews with relevant stakeholders Ground truthing Visits to extractive sites	Publications from MDAs, Universities, Research institutes at the national level, SADC, COMESA Information from Extractive Industries Satellite imageries Publications of international agencies across the globe.
KR3: Examine how the competition on biofuel production	• Land tenure (ownership	Secondary data Interviews with	Publications from MDAs, Universities, Research institutes at the national level, SADC,

Key result area	Type of data	Data collection procedure	Data Sources
impact on food production, land security and biodiversity habitat	structure, access and control) • Land use and land use change. • Types and trends (volume, extent and value, and production techniques) of biofuels. • Trends in land areas under food production. • Effects of bioenergy production on food production, land security and biodiversity.	relevant stakeholders Ground truthing through visits to extractive sites	COMESA. Information will also be sought from publications of international agencies across the globe.
KR4: Analyse the mechanisms supporting/incentivising the production and commercialisation of biofuels	• List of mechanisms and incentives • Value addition • Marketing information • GDP, poverty level, occupation	Secondary data Interviews with relevant stakeholders	Publications from MDAs, Universities, Research institutes at the national level, SADC, COMESA Publications from international agencies across the globe.
KR5: Evaluate policies, legislations and other factors influencing land shifts between the 3Fs and blending of liquid biofuels and fossil fuels and implications on carbon in the context of climate change	• Relevant policies and legislation. • Available technical support. • Changes in prices of fossil fuels • Land tenure. • Land use conflicts. • Economic returns associated with production of the 3Fs and blending	Secondary data Interviews with relevant stakeholders	Publications from MDAs, Universities, Research institutes at the national level, SADC, COMESA Publications from international agencies across the globe.
KR6: Assess fuel-wood and charcoal	• Policy documents (Forest, energy,	Secondary data	Viable business models for

Key result area	Type of data	Data collection procedure	Data Sources
policies and other practices that will make fuel wood and charcoal industry a viable business at national and sub-regional levels	trade policy particularly with reference to exportation of charcoal. • Production technologies • Pricing across value chain • Charcoal and fuelwood demand and supply at the country and sub-regional levels	Interviews with relevant stakeholders	charcoal and fuelwood production across the globe Publications from MDAs, Universities, Research institutes at the national level. Publications from international agencies across the globe.
KR7: Analyze strategies that will help track changes in the levels of production & consumption of fuelwood	• Existing Monitoring and Evaluation structure	Secondary data Interviews with relevant stakeholders	MDAs Relevant development Agencies
Recommendation: Provide appropriate key recommendations in relation to the outlined tasks.	Synthesis of information from the analysis and discussion of other terms of reference for the study	Consultant's expertise	

APPENDIX II: LIST OF STAKEHOLDERS CONTACTED IN STUDY COUNTRIES.

Zambia			
Name	**Position**	**Organisation**	**Contact**
Alastair Anton	Chief Technical Adviser	Indufor, Forestry Department	alastair.anton@indufor.fi
Ignatius Makumba	Director of Forestry	Forestry Department	inmakumba@gmail.com
Davies Kashole	National Project Coordinator	Forestry Department	dkashole@gmail.com
Deuteronomy Kasaro	Mitigation Specialist	Interim Climate Change Secretariat	deuteronomykasaro@znccs.org.zm
Davison Gumbo	Country Director	CIFOR	d.gumbo@cgiar.org
Mateyo Kaluba	Director – Planning & Information	Min. of Commerce, Trade & Industry	mckaluba@mcti.gov.zm
Abraham Makano	Events Coordinator	National Assembly	Abraham.makano@gmail.com
Jonathan Wesley	Chief Technical Advisor	Integrated Land Use Assessment Project, Forestry Department	jonathan.roberts@fao.org
Chikakula Miti		COMESA	CMiti@comesa.int

Zimbabwe			
Name	**Position**	**Organisation**	**Contact**
Eng. David Musariri	Deputy Director – Policy, Planning & Coordination	Min. of Energy & Power Development	dmusariri@energy.gov.zw
Barbara Mathemera	Policy Coordination Officer	FAO	mathemera@agriculture.gov.zw
Tafadzwa Mushonga	Sen. Research Officer	Forestry Commission	tafadzwa@frchigh.co.zw
Stephen Zingwena	Operations Manager	Forestry Commission	szingwenagmail.com
Darlington Duwa	General Manager	Forestry Commission	dduwa2014@gmail.com
Abedinigo Marufu	Deputy General Manager	Forestry Commission	abedinigo.marufu@gmail.com
Deborah Mugwada	Researcher	WWF	mmaunze@wwwsarpo.org
Millward Kuwona	Researcher	WWF	
Charity	Researcher	WWF	
Gladman Kundhlande	Director	SAFIRE	info@safire.co.zw
Madagascar			
Name	**Position**	**Organisation**	**Contact**
Andriambololoma Nana Benohery	Directeur de la Valorisation des Ressources Forestières	Ministère de l'Environnement, de l'Ecologie, de la Mer et des Forêts	cireeffen@yahoo.fr
Rabetaliana Hanta	Secretaire General	Ministry of Environment, Ecology and Forests	hrabetaliana@yahoo.fr

Augustin Randrianarivony	Directeur de l'Energie Alternative	Ministère de l'Energie et des Hydrocarbures	gista.randrianarivony@gmail.com
André Tahindro	Directeur Général de la Mer	Ministère de l'Environnement, de l'Ecologie, de la Mer et des Forêts	andre.tahindro@gmail.com
Jacquis Rasoanaina	Directeur des Aires Marines Protégées	Ministère de l'Environnement, de l'Ecologie, de la Mer et des Forêts	jacquis415@gmail.com
Rémi Ratsimbazafy	Directeur de la Préservation de la Qualité de la Mer et des Zones Côtières	Ministère de l'Environnement, de l'Ecologie, de la Mer et des Forêts	ratsimbazafy@gmail.com
Tsimisanda Henri Michel	Advisor	Min. of Industry & Private Sector Development	tsimisandahenri@yahoo.fr
Andrianjaka Rajaonarison	Madagascar Project Co-ordinator	International Network for Bamboo & Rattan	arajaonarison@inbar.int
Lydie Raharimaniraka	Coordinator of International Conventions	Ministry of Environment, Ecology, Oceans & Forestry	lymaniraka@yahoo.fr; dvrn@meeft.mg
Louis Muhigirwa	Deputy Representative of FAO in Madagascar, Comores, Maurice et Seychelles	FAO	louis.muhigirwa@fao.org
Guybertho Randrianarivelo	FAO Policy Development Consultant	FAO	guybertho@gmail.com

Malawi			
Name	**Position**	**Organisation**	**Contact**
Shamiso Najira	Chief Environmental Officer	Environmental Affairs Department	shamiso_b@yahoo.com
Gertrude Kambauwa	Principal Officer	Dept. of Land Resources Conservation, Min. of Agriculture, Irrigation & Water Development	gkambauwa@gmail.com
Chikaiko Chadzunda	Managing Director	Bio Energy Resources Ltd.	c.chadzunda@berl.biz
Derek Zamaere	Operations Manager	Ethanol Company Ltd	dzamaere@ethanolmw.com
Clement Chilima	Director of Forestry	Department of Forestry	cchilima@gmail,com
Lewis Mhango	Director of Energy	Department of Energy	
Mustafa Kaunde	Principal Forestry Officer	Forestry Department	mustaphakaunde@yahoo.co.uk
William Chadza	Executive Director	Center for Environmental Policy and advocacy (CEPA)	william@cepa.org.mw
Henry Harry Kadzuwa	Head-GIS and Remote Sensing Unit	Forestry Department	hkadzuwa@yahoo.co.uk
Isaac Nyoka	Team Leader	ICRAF	bnyoka@yahoo.com

APPENDIX III: SELECTED FOREST HOTSPOTS OF STUDY COUNTRIES

Country	Total Forest Area (ha)	Name	Forest type	Hectares	
Malawi					
	3,237,000	Dzalanyama	Miombo	98,934	
		Thambani	Miombo	12,312	
		Neno	Miombo	6,404	
		Thuma	Miombo	16,395	
		Perekezi	Miombo	14,760	
		Ndirande	Miombo	1,709	
		Zomba-Malosa	Miombo	14,536	
		Namizimu	Miombo	86,994	
		Kalulu	Miombo	2,823	
		Kasungu, Nkhotakota	Miombo	125,764	
		Thyolomwani	Miombo	932	
Madagascar					
	10,659,036	Alaotra Mangoro	Tapia/Mangrove	544,420	
		Amoron'i mania	Tapia/Mangrove	55,931	
		Atsimo Andrefana	Dry Forest	2,063,055	
		Boeny	Dry Forest	397,335	
		Melaky	Dry Forest	552,229	
		Menabe	Dry Forest	941,852	
		Itasy	Tapia/Mangrove	496	

Zambia					
	49,468,000	Lusaka	Miombo	2,189,571	
		Central Province	Miombo	9,439,448	
		Copperbelt	Miombo	3,101,400	
		Eastern Province	Miombo	6,910,590	
		Luapula	Miombo	5,056,681	
		Northern Province	Miombo	14,782,582	
		Nwestern Province	Miombo	12,614,091	
		Southern	Miombo	8,528,293	
		Western	Miombo	12,638,590	
Zimbabwe					
	15,624,000	Not identified	Mainly miombo		

APPENDIX IV A: AREA STATISTICS FOR THE FOREST COVER 1990, 2000 AND 2010 IN THE MALAWI/ZAMBIA TRANS-BOUNDARY SITE.

Overview – Forest Cover and Land Use Change 1990, 2000 and 2010				
Description	**Area [km^2]**			**Uncertainty [%]**
	TOTAL	***Malawi***	***Zambia***	
Overall interpretable area in 1990 (without clouds, cloud shadow and background areas	**26,079.53**	*12,576.37*	*13,503.16*	N/A
Overall interpretable area in 2000 (without clouds, cloud shadow and background areas	**26,079.53**	*12,576.37*	*13,503.16*	N/A
Overall interpretable area in 2010 (without clouds, cloud shadow and background areas	**26,079.53**	*12,576.37*	*13,503.16*	N/A
Situation in 1990 (in reference to the overall interpretable area)				
Forest land in 1990	**18,293.93**	*7,058.22*	*11,181.71*	±3.37
Non-Forest land in 1990	**7,839.60**	*5,518.15*	*2,321.45*	±7.29
Situation in 2000 (in reference to the overall interpretable area)				
Forest land in 2000	**16, 358.91**	*6,186.68*	*10,172.23*	±3.56
Non-Forest land in 2000	**9,720.61**	*6,389.68*	*3,330.93*	±6.03
Situation in 2010 (in reference to the overall interpretable area)				
Forest land in 2010	**15,394.04**	*5,870.66*	*9,523.38*	±3.95
Non-Forest land in 2010	**10,685.48**	*6,705.70*	*3,979.78*	±5.65

Source: GIZ SADC Operations Report (2014)

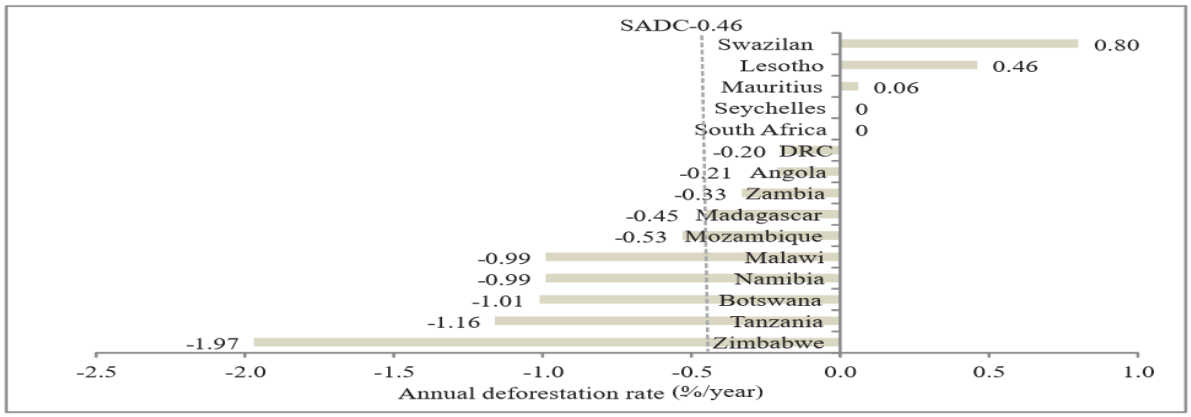
APPENDIX IV B: AREA STATISTICS FOR THE FOREST COVER AND LAND USE CHANGE 2000 – 2010 IN THE MALAWI/ZAMBIA TRANS-BOUNDARY SITE

Overview – Forest Cover and Land Use Change 1990 - 2000				
Description	**Area [km^2]**			**Uncertainty [%]**
	TOTAL	***Malawi***	***Zambia***	
Overall interpretable area in 1990 & 2000 (without clouds, cloud shadow and background areas	**26,079.53**	*12,576.37*	*13,503.16*	N/A
Forest/Non-Forest Situation in 2010 (in the overall reference to interpretable area)				
Forest Land in 2010	**15,517.28**	*5,918.01*	*9,599.27*	±3.95
Non-Forest Land in 2010	**10,562.25**	*6,657.63*	*3,903.89*	±5.65
Unchanged Land Use (in reference to the overall interpretable area)				
Forest land in 2000 remaining Forest Land in 2010	**15,405.79**	*5,901.73*	*9,584.06*	±2.55
Non-Forest land in 1990 remaining Non-Forest land in 2010	**9,788.23**	*6,428.55*	*3,359.67*	±4.50
Changes in Forest Land in 2000 to Non-Forest Land in 2010 (Gross Deforestation)				
Forest Land in 2000 to Cropland in 2010	**614.10**	*117.75*	*496.35*	±14.57
Forest Land in 2000 to Grassland in 2010	**159.47**	*111.84*	*47.63*	±6.65
Forest Land in 2000 to Wetland in 2010	**0,00**	*0.00*	*0.00*	N/A
Forest Land in 2000 to Settlement in 2010	**0.45**	*0.21*	*0.24*	±4.62
Forest Land in 2000 to Other Land in 2010	**0.00**	*0.00*	*0.00*	N/A
Sum (Gross Deforestation)	**774.02**	*229.08*	*544.22*	±7.80%

Gross increase in Forest Area				
Non-Forest in 2000 to Forest Land in 2010*	**31.49**	*16.28*	*15.21*	±1.79%
Summary Changes 2000to 2010				
Gross Deforestation Area	**774.02**	*229.08*	*544.22*	±7.80%
Gross Annual Deforestation Area	**77.40**	*22.91*	*54.42*	±0.78%
Gross Annual Deforestation Rate	**0.50%**	*0.37%*	*0.53%*	N/A

Source: GIZ SADC Operations Report (2014)

APPENDIX IV C: ANNUAL RATE OF DEFORESTATION, SADC COUNTRIES, 2005–2010



Source: FAO (2010)

APPENDIX V: GREENHOUSE GAS EMISSIONS (KT OF CO_2 EQUIVALENT) IN THE STUDY COUNTRIES.

Year	Zambia	Change	Madagascar	Change	Malawi	Change	Zimbabwe	Change
1970	234,168		45,314				24,034	
1971	132,575		31,700		4,125		21,405	
1972	142,671		33,415		4,555		21,231	

Year	Zambia	Change	Madagascar	Change	Malawi	Change	Zimbabwe	Change
1973	153,120		35,221		4,853		23,156	
1974	133,430		33,167		4,569		22,590	
1975	158,349		36,664		5,377		22,662	
1976	140,275		34,579		5,284		23,325	
1977	161,328		38,184		5,747		23,277	
1978	170,040		40,516		6,105		22,595	
1979	224,649		47,801		7,349		23,746	
1980	185,988		43,739		6,611		22,756	
1981	161,735		40,817		6,281		21,833	
1982	183,355		43,685		6,823		22,737	
1983	183,319		44,142		6,835		22,614	
1984	141,719		39,061		6,124		21,986	
1985	144,149		39,488		6,426		23,896	
1986	134,958		38,196		6,515		26,007	
1987	188,042		44,748		7,910		28,160	
1988	132,224		38,388		6,550		29370	
1989	149,005		40,359		7,168		30264	
1990	209,649		48,353		8,537		35101	
1991	174,045	-16.98	43,906	-9.20	7,969	-6.66	34133	-12.76
1992	278,260	32.73	57,426	18.76	10,138	18.76	38276	9.05
1993	156,527	-25.34	42,515	-12.07	7,510	-12.03	30183	-14.01
1994	182,687	-12.86	45,839	-5.20	7,782	-8.84	30209	-13.94
1995	185,179	-11.67	46,521	-3.79	8,132	-4.74	30377	-13.46
1996	156,681	-25.27	43,116	-10.83	7,698	-9.82	30570	-12.91
1997	149,987	-28.46	42,210	-12.70	7,585	-11.16	29469	-16.04
1998	448,614	113.98	142,476	194.66	17,454	104.45	76392	117.64

Year	Zambia	Change	Madagascar	Change	Malawi	Change	Zimbabwe	Change
1999	328,964	56.91	90,964	88.12	13,768	61.28	66725	90.1
2000	290,812	38.71	84,187	74.11	15,450	80.98	51435	46.53
Av.	**232,855**		**62,501**		**10,184**		**41,170**	
2000	290,812	38.71	84,187	74.11	15,450	80.98	51435	46.53
2001	297,453	41.88	131,803	172.58	12,365	44.84	58453	66.53
2002	300,362	43.27	84,562	74.88	14,273	67.19	50282	43.25
2003	356,025	69.82	163,798	238.75	20,341	138.26	48217	37.37
2004	368,996	76.01	87,784	81.55	15,083	76.68	61473	75.90
2005	396,447	89.10	159,819	230.52	20,503	140.17	59895	70.64
Av.	**335,016**		**118,659**		**16,336**		**54,959**	
2005	396,447	89.10	159,819	230.52	20,503	140.17	59895	70.64
2006	314,794	50.15	107,263	121.83	15,055	76.35	55535	58.22
2007	341,006	62.66	134,285	177.72	17,520	105.22	60918	73.55
2008	321,164	53.19	94,468	95.37	17,735	107.74	68841	96.12
2009	266,119	26.94	117,985	144.01	15,596	82.68	67914	93.48
2010	319,785	52.53	117,231	142.45	21,416	150.85	71,019	102.33
Av.	**326,553**		**121,842**		**17,971**		**64,020**	
2011	320,025	52.65	117,586	143.18	21,526	152.14	71562	103.88
2012	320,254	52.76	117,933	143.90	21,632	153.39	72058	105.29

Note: Bracketed bold figures are average annual GHG emissions for 1990-2000, 2000-2005 and 2005-2012 periods.

Source: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR): http://edgar.jrc.ec.europa.eu/.

APPENDIX VI: CHANGES IN DEFORESTATION, EMISSIONS AND ELECTRICITY TARIFFS IN SELECTED COUNTRIES.

Country	Annual rates of change								
	1990 - 2000		2000 - 2005			2005 - 2012			2015
	Deforestation (% change)	Av. annual (10,000) GHG Emissions (kt CO_2 equiv.)	Deforestation (% change)	Av. annual (10,000) GHG Emissions (kt CO_2 equiv.)	Av. end user electricity tariff increase (USc/kWh)	Deforestation (% change)	Av. annual (10,000) GHG Emissions (kt CO_2 equiv.)	Av. end user electricity tariff increase (USc/kWh)	End user electric. tariff increase (USc/kWh)
Angola	-0.2		-0.2		9.19			9.95	3.10
Botswana						-0.9			-
Lesotho									-
Madagascar	-0.8	6.250	-0.5	11.866		-0.4	12.184	-	-
Malawi	-0.9	1.018	-0.9	1.634	7.00	-2.4	1.797	8.00	8.00
Mauritius						-0.6			-
Mozambique	-0.3		-0.3		6.63	-0.2		7.14	8.15
Namibia					8.73	-0.9		8.73	15.00
South Africa					4.05	-0.1		5.48	6.22
Swaziland					6.80	1.2		10.09	11.72
Tanzania	-1.0		-1.1		9.29	-0.2		10.44	16.04
Zambia	-0.9	23.286	-1.0	33.502	2.53	-2.4	32.655	5.03	6.00
Zimbabwe	-1.5	4.117	-1.7	5.496	0.82	-1.5	6.402	4.20	9.86
Madagascar*	-0.8	6.250	-0.5	11.866	-	-0.4	12.184	-	-
Malawi	-0.9	1.018	-0.9	1.634	7.00	-2.4	1.797	8.00	8.00
Zambia	-0.9	23.286	-1.0	33.502	2.53	-2.4	32.655	5.03	6.00

Country	Annual rates of change								
	1990 - 2000		2000 - 2005			2005 - 2012			2015
	Deforestation (% change)	Av. annual (10,000) GHG Emissions (kt CO_2 equiv.)	Deforestation (% change)	Av. annual (10,000) GHG Emissions (kt CO_2 equiv.)	Av. end user electricity tariff increase (USc/kWh)	Deforestation (% change)	Av. annual (10,000) GHG Emissions (kt CO_2 equiv.)	Av. end user electricity tariff increase (USc/kWh)	End user electric. tariff increase (USc/kWh)
Zimbabwe	-1.5	4.117	-1.7	5.496	0.82	-1.5	6.402	4.20	9.86

Source: Adapted from Magombo *et al.* (2010); AECOM International Development (2011); Kaunda (2014); RERA (2011); Sikwanda (2016); European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR): http://edgar.jrc.ec.europa.eu/.

APPENDIX VII: A COMPARATIVE ANALYSIS OF POLICY FRAMEWORKS ON CHARCOAL

Country	Governing policy provisions	Implications/Impacts/Gaps
Madagascar	1997 Forestry Policy, under review, allows for sustainable charcoal production through SFM. Innovative approaches along supply chain; institutional framework, decentralised management of woodlots/plantations.	Policy and legislative framework, enabling best practices of SFM, allocation of landscapes with secure tenure rights (land title), long-term user rights to households, new forest resources, institutional and technical support, afforestation/reforestation. Interventions for improved value chain; one of the best models for a well-organised, community-based SFM.
Malawi	1996 Forest Policy, Forestry Act (1997) allows charcoal production from sustainably managed forests under license otherwise illegal; need approval of management plan and application for a license. 2003 Energy Policy supporting more controls on charcoal production. **New 2016 National Forest**	1996 Policy, extent of sustainability unclear (presumed broad SFM initiatives); complexity of management plan, tenure created no incentives to legally participate in the industry, effectively making charcoal production and trade illegal. The new 2016 Policy recognizes the inadequate supply of electricity, LPG and/or biogas increasing firewood and charcoal demand and exacerbating already high deforestation rate. Implementation Strategy/Approach: to grow trees by involving all sections of community for

Country	Governing policy provisions	Implications/Impacts/Gaps
	Policy: more specific, focused approach, promoting sustainable production of firewood & charcoal, improved production and efficient use.	self-sufficiency, green charcoal production and utilization through improved and efficient charcoal kilns and clean cook stoves.
Namibia	Policy framework allow innovative charcoal production as by-product of clearing invader bush; industry grew significantly in the 2001–2010 period and now become an important economic sector. Policy created, in terms of formal and international trade in wood energy, one of the most organised commercial charcoal producers in Southern Africa, with the industry exporting charcoal to markets in Germany, UK, RSA, apart from satisfying local consumption.	Namibia to rely on fuelwood for the foreseeable future; charcoal industry a major economic activity. Challenges: labour-intensive industry of indigent and unskilled labourers falls outside labour protection, health and safety laws as industry remains unregulated. Negotiations for better working conditions under way for years and no final agreement reached yet. Annual inspections and strategic environmental assessment at charcoal production sites needed to ensure permit requirements, cutting and harvesting procedures (even to safeguard inclusion of *Colophospermum mopane*) as a protected species against its widespread use for charcoal) are followed properly; to identify magnitude of environmental and socio-economic impacts of the industry.
Tanzania	National Energy Policy, 2015 recognising woodfuel as most widely used form of energy, but fails to provide specific policy objectives or statements to guide sustainability. However, the Forest Act (2002), Charcoal Regulations (2006), and Guidelines for Sustainable Harvesting and Trade in Forest Produce (2007) provide legal basis for production and trade. A set of policies & legislation by different organs of government influencing management.	Charcoal value chain is complex, policies are interlinked involving many sectors, including energy, forestry, agriculture, transport, and even health. As a result, as wood is converted to and then used for energy, along its value chain, policy responsibility becomes more complicated as different sectors take different responsibilities.To reduce environmental impacts due to high demand, government must introduce charcoal as a business and put appropriate and workable policies for its sustainable use. Challenge in developing charcoal policy: comprehensive approach, entire value chain, inter-agency and cross-sector coordination through a policy dialogue and requisite institutional and administrative frameworks.
Zambia	From 1940s through to implementation of the 1998 National Forestry Policy, centralised policy, focused on licensing removal and trade of forest products; collection of revenue from forest produce, among them charcoal. 1995,	1998 National Forestry Policy not fully implemented due to non-commencement of the Forest Act of 1999, non-establishment of the enabling institutional structure, Zambia Forestry Commission; escalated unsustainable charcoal production, deforestation and forest degradation. New Policy views charcoal as an alternative to other energy sources such as electricity and gas in national

Country	Governing policy provisions	Implications/Impacts/Gaps
	2007 Energy Policies supported more controls on improved charcoal production & efficiency (e.g., better kilns), adoption of fuel-efficient stoves. Various environmental policies supported SFM and charcoal production. **New 2014 National Forestry Policy**: Policy Statement specifically recognises importance of charcoal as major source of energy and income for peri-urban and urban; measures to ensure sustainable production to reduce deforestation & contribute to livelihoods.	energy mix, with strategy to create awareness on impact of unsustainable production on environment, socio-economic and climate change; design and set aside production areas; provide guidelines for production on farmlands and other areas; put in place charcoal tracking system to ensure sustainable harvest of trees and production; provide technical support for production to enhance SFM; regulate exports; and promote efficient charcoal production methods. Promote active participation & roles of all stakeholders at all levels of decision-making, implementation, M&E, resource tenure, cost-benefit sharing mechanisms, investments and forest industry development. Align to other national and regional frameworks in view of declining forest ecosystems
Zimbabwe	Currently no specific charcoal policy, though law enforcement very effective, with stiff penalties. Used mainly as 'industrial charcoal' for chemical development under 2012 National Energy Policy and National Biofuels Enerygy Policy (being developed, in draft form), which advocates liquid fuels for the transport sector, for biothermal and biochemical purposes. However, National Forestry Policy being developed to address charcoal emerging issues but will not allow commercialization of forest products except those with value addition.	Charcoal not traditionally used in the household sector, relying primarily on forewood, therefore not at all competitive; even price of wattle hardwood charcoal produced by Wattle Company uncompetitive with other solid fuels, especially coal. Existing market for hardwood charcoal is therefore very small, mainly limited to "barbecuing" and cooking selected dishes (as an external influence) and the extent of charcoal demand by this segment is not known; needs to be further investigated, together with claims of increasing demand due to high electricity tariffs, particularly in urban areas. While thousands of tonnes of charcoal annually produced from other countries of Southern Africa, this is not widespread in Zimbabwe. Industrial charcoal production is limited to a few small scale commercial schemes by the Wattle Company Ltd., Forestry Commission and a private company in Kwekwe, all directly associated with commercial plantation or land clearing schemes.

APPENDIX VIII: PRODUCTION, CONSUMPTION AND TRADE OF ROUNDWOOD, SAWNWOOD AND OTHER WOOD PRODUCTS IN THE SADC REGION IN 2003, 2006 AND 2011.

i) Industrial wood production and consumption in the SADC region in 2003.

Wood product	Production (x1000 m³)	Consumption (x1000 m³)	Variance (x1000 m³)
Roundwood	185 998	185 546	452
Industrial Roundwood	29 904	29 454	450
Wood Charcoal	5 692	5 646	46
Sawnwood	2 394	2 701	-307
Wood-Based Panels	623	747	-124
Plywood	71	108	-37
Sawlogs and Veneer Logs	8 257	No data	No data
Other Industrial Roundwood	12 049	No data	No data
Wood Pulp	2 476	1 306	1170
Chemical Wood Pulp	1 655	1 017	638

Source FAO (2005).

ii) Production, trade and consumption of woodfuel, roundwood and sawnwood in the SADC region in 2006.

Country/area	Woodfuel (x1000 m³)				Industrial roundwood (x1000 m³)				Sawnwood (x1000 m³)			
	Prod	Imp	Exp	Cons	Prod	Imp	Exp	Cons	Prod	Imp	Exp	Cons
Angola	3656	0	0	3656	1096	2	4	1093	5	1	0	6
Botswana	665	0	0	665	0	0	105	0	0	0	0	15
DRC	72126	0	0	72126	4322	1	89	4234	94	1	69	26
Lesotho	2061	0	0	2061	0	0	0	0	0	0	0	0
Madagascar	11339	0	0	11339	183	0	43	140	89	1	28	62
Malawi	5189	0	0	5189	520	2	0	521	45	0	16	29
Mauritius	7			7	9	20	1	28	4	65	1	68
Mozambique	1674	0	0	1674	1304	4	133	1175	43	19	19	43
Namibia	–	–	–	–	–	–	–	–	–	–	–	–
Seychelles	0	0	0	0	0	0	0	0	0	0	0	0
South Africa	1200	0	0	1200	18063	51	191	17922	2 091	487	63	2516
Swaziland	996	0	0	996	330	0	0	330	102	0	0	102
Tanzania	21914	0	1	21914	2314	2	57	2259	40	1	32	10
Zambia	8798	0	0	8798	1325	0	1	1325	157	1	6	153
Zimbabwe	8380	0	0	8380	771	1	5	767	565	2	83	484
SADC	138005	0	1	138005	30237	83	629	29794	1144	578	317	3514

Source FAO (2009) Prod = Production; Imp = Imports; Exp = Exports; Cons = Consumption

iii) Production, trade and consumption of woodfuel, roundwood and sawnwood in the SADC region in 2011.

Country /Area	Woodfuel		Industrial roundwood (1000 m ^{3})				Sawnwood (1000 m ^{3})			
	Production	Consumption	Production	Imports	Exports	Consumption	Production	Imports	Export	Consumption
DRC	1295	1295	2431	1	251	2180	265	0	40	228
Mauritius	7	7	9	3	0	11	3	25	0	28
Madagascar	11910	11910	277	16	16	277	92	1	35	58
Seychelles	0	0	0	0	0	0	0	0	0	0
Tanzania	22352	22352	2 314	0	6	2308	24	4	22	6
Angola	3828	3832	1096	2	6	1092	5	3	0	8
Botswana	674	674	105	0	0	105	0	15	0	15
Lesotho	2076	2076	0	0	0	0	0	0	0	0
Malawi	5293	5291	520	0	9	511	45	0	45	0
Mozambique	16724	16724	1 304	10	14	1300	57	13	47	23
Namibia	0	0	0	0	0	0	0	0	0	0
South Africa	19560	19561	19867	60	237	19654	2056	488	55	2488
Swaziland	1028	1028	330	0	0	330	102	0	0	102
Zambia	8 840	8840	1325	4	5	1324	157	5	25	137
Zimbabwe	8543	9543	771	2	3	770	565	1	54	512
Total	**102130**	**103133**	**30349**	**98**	**547**	**29862**	**3371**	**555**	**323**	**3607**

Source: FAO (2011)

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African Forest Forum
P.O. Box 30677-00100
Nairobi GPO KENYA
Tel: +254 20 722 4203 Fax: +254 20 722
4001 E-mail: exec.sec@afforum.org
Website: www.afforum.org