The role of forests in a green economy transformation in Africa

Maryanne Grieg-Gran, Steve Bass, Francesca Booker and Mike Day

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Front cover photo: NAMPULA, MOZAMBIQUE, May 2010: Green Resources have been allocated a concession of 100,000 hectares to grow eucalyptus for paper pulp, for construction and for charcoal.

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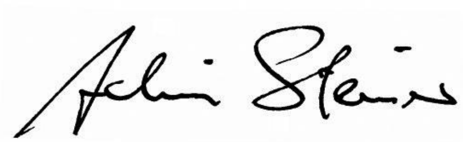
Foreword

African economies are often rooted in abundant natural resources drawn from the myriad ecosystems that blanket the continent. Forests are an integral part of this fabric. Covering some 35 per cent of Africa's land area, they can claim to be pillars of many African economies. For their contribution to remain reliable and strong, forest products and services will need to be wisely developed and intelligently used as African countries transition towards the green economy.

This report - the fruit of an enjoyable collaboration between UNEP and IIED - provides an analysis of the role of Africa's forests in the continent's future green economies. The report points to stark, problematic realities for people of Africa, markets and ecosystems from continuing deforestation and forest degradation. However, it also offers a glimpse of the positive potential of forests as countries shift toward resource-efficient and sustainable green economies.

Drawing on cases studies from Cameroon, Ethiopia, Ghana, Kenya, Mozambique and South Africa, this report looks at successes and failures, obstacles and opportunities for forests in Africa. What is clear is that democratic decision-making and local leadership are crucial to enjoy sustainable benefits of this natural capital. Access to financing and green investment will also be imperative.

Policymakers would do well to draw on this report's recommendations for linking REDD+ planning with a green economy and sustainable investments. The transformation to a sustainable green economy in many countries will depend on the forward-looking sustainable management of forests - one of Africa's most bountiful and important ecosystems.



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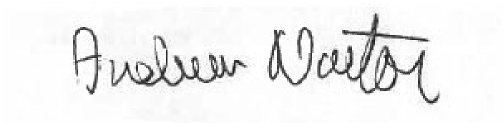

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Executive summary

This report explores the role of forests in a green economy transformation in Africa. Its aim is to present policymakers with a strong rationale for linking forests and REDD+ planning with green economy planning and investments. According to UNEP (2012), a green economy '*results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities'.* Africa is achieving high GDP growth rates but still faces challenges to reduce poverty and create sufficient jobs. As Africa's economies are highly dependent on natural resources, the ability to generate growth in the future and meet wider development priorities will depend on what happens to key resources like forests. For this reason green economy approaches are increasingly relevant to Africa.

We first establish the rationale for linking forests and green economy. Forest resources contribute to a green economy in Africa in diverse ways– providing wood products, generating income and jobs, meeting needs for food, energy and medicinal plants and delivering regulating and supporting ecosystem services. While sector wood and fibre production tend to be the focus of economic policy-making and of official statistics, the formal forest sector is declining relative to other productive sectors and import dependence is increasing. The other forest contributions are less well-documented but in terms of livelihoods are hugely important. In particular, most of the wood extracted in Africa is used for woodfuel, primarily for household cooking and not for wood products (FAO, 2012b).

The report goes on to examine the main threats to the forest resource base starting with the fundamental issue of overlapping rights to forest resources in that informal rights associated with traditional systems of governance are rarely given official recognition undermining local users' incentives to invest in good management. Deforestation, driven as much by agriculture as by forest resource extraction, is proceeding at a high rate while logging is contributing to forest degradation as rotations get progressively shorter. Only a small proportion of Africa's production forests can be considered sustainably managed (Blaser *et al.,* 2011). Over-harvesting of woodfuel and non-Wood Forest Products (NWFPs) is also contributing to forest degradation in certain locations close to markets. We find that Africa's forests are closely linked with green economy in the region but that their potential is not being fully realised.

Business-as-usual (BaU) scenarios to 2030 and 2050 are developed, incorporating likely demand trends for wood and woodfuel based on expected growth in population and GDP. These are matched with estimates of the potential supply of industrial roundwood given the outlook for planted forests and deforestation. These scenarios indicate that demand for industrial roundwood could be two to three times current levels by 2050. To meet such demand from the existing natural forest designated for production will require harvesting intensities well above sustained yield, putting severe strain on the forest resource base, already threatened by deforestation. This could be exacerbated also by localised shortages of woodfuel. If the natural forest resource base continues to decline as a result of deforestation and degradation from logging, it will become more and more difficult to meet demand without drastically increasing import dependence. The effect of this high level of demand and the pressures from other sectors, agriculture particularly, will have a deleterious effect on the ability of forests to deliver key ecosystem services - carbon emissions will increase and biodiversity will be threatened as harvesting intensity exceeds key levels.

A number of interventions that have been tried out in various locations in African countries provide glimpses of the potential of forests to contribute to a green economy transformation. The report draws on examples from six countries, **Cameroon, Ethiopia, Ghana, Kenya, Mozambique** and **South Africa**, to illustrate the pitfalls and advantages of different types of intervention and to highlight contextual factors that are important in assessment. Interventions focused on managing, enhancing and restoring **natural capital** have shown that it is possible to meet high environmental standards of sustainable forest management (SFM) in both natural forests and planted forests and that a major challenge is to manage social relationships and ensure lasting benefits for local communities. Another group of interventions have demonstrated that there is considerable scope to increase **resource efficiency** in tree-planting, wood processing, charcoal processing and cooking stoves through new technology, improved handling and storage practices and supply chain organisation. This can reduce pressure on forest resources and in the case of cooking stoves result in significant benefits for low income families, women and girls particularly, from reduced pollution-related health effects and time savings in woodfuel collection and cooking. The challenge is in securing high levels of uptake and overcoming barriers such as financial constraints, lack of capacity and cultural preferences. **Sustainable consumption** interventions are reinforcing the other two types of intervention (natural capital and resource efficiency), driving improvements from the demand side, often as part of international regulatory or supply chain initiatives or certification schemes and to a lesser extent in the form of national l demand initiatives to promote sustainable locally produced goods made from wood or NWFPs.

This is followed by scenario analysis of the implications of some of these interventions with a focus on two major uses of forest resources: timber and woodfuel. Sustainable management of natural forests, at a harvesting intensity compatible with sustained yield, increases the likelihood that the forest resource base will be maintained. But by 2030, and 2050, the demand for industrial roundwood is projected to be so high that the forest resource base may not produce enough to meet demand. However, when SFM in natural forests is combined with a package of other green economy interventions, the shortfall in wood supply is greatly reduced or eliminated altogether depending on the scenario and associated assumptions. This package includes expansion in the area and productivity of planted forests, increase in the efficiency with which wood is processed, and reduction in deforestation primarily by addressing low agricultural productivity. This package of interventions would therefore help to secure the future of the forest sector and its contribution to GDP and employment. Similarly, woodfuel interventions to improve technology can reduce wood demand, relieving pressure on wood resources in areas of localised shortages and reducing carbon emissions.

The key message from the scenario analysis is that a package of natural capital and resource efficiency interventions can in theory ensure the future of the forest resource, while meeting increasing demand. This would be without major compromise to the other contributions of the forest resource to ecosystem services that underpin a whole range of growth sectors. But in practice there are considerable obstacles to overcome for the interventions reviewed to bring about a green economy transformation. For these interventions to be scaled up, improvements are needed to the enabling environment. These include:

- Improved forest governance through wider stakeholder participation in forest decision-making processes, encompassing informal users of forest resources.
- Work towards local control and new models of engagement with local people/forest communities.
- A more nuanced approach to the informal sector which recognises that some actors within it are working legitimately even if not within the law and encourages good practice.
- Promote access to finance by improving the investment climate and funding enabling investments in capacity-building, and risk management.
- Improve inter-sectoral coordination so that policy measures in sectors that affect or are affected by forests are coherent with those in the forest sector.
- Improve information on forest assets to document the contribution made by forest ecosystem services to different sectors, and deploy in economic development planning and reporting.

1. Introduction

This report explores the role of forests in a green economy transformation in Africa. Its aim is to present policymakers with a strong rationale for linking forests and REDD+ planning with green economy planning and investments.

Africa has achieved relatively high GDP growth rates in recent years and these are expected to continue over the next decade at least (AfDB, 2011), but the region still faces severe challenges to reduce poverty and generate jobs and secure livelihoods for its rapidly increasing population. At the same time, given the relatively high dependence of national economies and livelihoods in Africa on natural resources, there is increasing recognition that climate change and environmental degradation pose serious risks to economic development and prospects of employment generation. The ability to generate growth in the future and to meet wider development priorities will increasingly depend on the maintenance and improvement of the natural resource base and its productivity. For this reason, green economy approaches are increasingly relevant to Africa.

According to UNEP (2012), a green economy '*results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities'.* This conceptualisation links green economy closely with human wellbeing, emphasising a social dimension as well as an environmental one. But how this is translated into specific green economy plans and policies is key.

Forests are a foundation of a green economy sustaining a wide range of sectors and livelihoods (UNEP, 2012). The contribution of forests to green economy is more than the production of timber. Forests improve people's wellbeing in numerous ways: directly by providing resources for basic needs such as energy, shelter and food; and indirectly by providing the ecological foundations for GDP in many other sectors: agriculture, tourism, water supply, health etc. Considerable attention is being given now to the role of forests in climate change mitigation under the banner of REDD+. This can also be an entry point for recognising the various non-marketed or under-valued services that forest landscapes provide beyond climate change mitigation.

In spite of their green economy potential and the momentum behind REDD+, forests have remained on the margins of international discussions around the green economy. Most of the national green economy plans that are currently under preparation, focus on major investments in energy-efficient or zero-carbon infrastructure as a means of greenhouse gas abatement. Many are shaped by the green economy/green growth programmes of international organisations, and aim to attract international climate finance. Yet the majority of participants in IIED-facilitated national dialogues on green economy in selected African, Asian and Latin American countries gave priority to enterprises that make sustainable use of natural resources. These were identified as potential sources of growth and jobs, and as such particularly suited to poorer countries and poorer groups (Bass, 2013). Far too few green economy plans have got to grips with the natural resource and ecosystem services potential of forests, and with the opportunities for poor people who largely operate in the informal economy.

1.1 A green economy forest vision for Africa

What would be achieved if forests were governed as a green economic sector? What outcomes should we look out for as existing signs of progress on which to build?
Our vision for a green economy approach to forests in Africa is that it will result in better, more secure lives for people and a more productive natural capital base:

- African people's welfare derived from forest ecosystem services will increase – decent jobs, secure livelihoods and income, health, freedoms, and culture.
- African forest ecosystems will be more productive, secure and restored – the productivity of forests will increase, enabling the above benefits
- The ecological limits of forest removal or use will be identified and respected – keeping climate, biodiversity and other 'planetary boundaries' at bay, enabling a 'safe operating space' for humanity
- Resilience will be built into African forest landscapes, societies and economies – forest institutions' capability to manage risks and scarcities, adapt to climate change, and diversify economic activity will offer much to society as a whole.

Although we call it a 'green' economy vision, this is fundamentally a human agenda. It is informed by the environmental assets and hazards connected to forests but also by the human and social capital linked to forests and the urgent need to improve people's wellbeing. As such it emphasises inclusion of stakeholders in forest decision-making processes and equitable distribution of costs and benefits.

1.2 What counts as a forest?

In line with our emphasis on green economy as a human agenda, in this report we go beyond the standard definitions of forests to focus on forest landscapes including trees outside forests or on farms. For example, FAO's official definition of forests covers a broad spectrum from natural forests undisturbed by human intervention, natural forests with varying degrees of human modification, and various types of planted forests from semi-natural to intensive high yield plantations – but excludes agroforestry. We are interested in all these types but also in various agroforestry systems even if they are not part of current strict definition of forests: they often provide many, if not all, forest ecosystem services and are important for livelihoods.

1.3 Structure of the report

In Chapter 2, we establish the rationale for linking forests and green economy. We examine the diverse ways in which forest resources contribute to a green economy in Africa – providing wood products, generating income and jobs, meeting needs for food, energy and medicinal plants and delivering other key ecosystem services. We go on to examine the main threats to the forest resource basis. And we develop business-as-usual scenarios to 2030 and 2050 of the likely outcomes in the absence of major policy and institutional change.

In Chapter 3, we examine challenges and opportunities to introduce green economy interventions. This review draws on examples from six countries, Cameroon, Ethiopia, Ghana, Kenya, Mozambique and South Africa, to illustrate the pitfalls and advantages of different types of intervention and to highlight contextual factors that are important in assessment. This is followed by scenario analysis of the implications of some of these resources with a focus on two major uses of forest resources: timber and woodfuel.

The final chapter draws out the main conclusions from this analysis and considers the enabling conditions necessary for success.

2. Establishing the rationale for linking forests and a green economy

2.1. Africa's forest resources

Africa has 675 million hectares of forest and 350 million hectares of wooded land which together cover 35 per cent of its total land area (FAO, 2010a). This includes tropical moist forests primarily in Central and West Africa, tropical dry forest, mostly in East and Southern Africa, including the miombo woodlands in Tanzania and Mozambique, and Mediterranean forests and woodland in North Africa.

This section explores the diverse ways in which Africa's forest resources currently play a role in development. It highlights the main threats to the forest resource base on which these green economy contributions depend, examining likely future trends in demand for forest goods and services and the implications for forest resources. On this basis it develops business as usual (BaU) scenarios to 2030 and 2050 of likely outcome for forests in Africa and their green economy contribution, in the absence of major policy and institutional change.

2.2. Contribution of forests to green economy objectives

2.2.1 Overview

Forests are one of the foundations of the green economy in Africa sustaining not just the formal wood processing industry but also a large informal sector. They meet subsistence needs for food, energy, and medicinal plants and deliver key regulating and supporting ecosystems services of local, national and global significance.

2.2.2 Wood harvesting and processing

Africa has a wood harvesting and processing industry which ranges from large multinational/foreign-owned companies to small and medium enterprise and informal activities. The formal wood harvesting and processing industry currently generates around US$17 billion per year and contributes just less than 1 per cent of Africa's GDP (FAO, 2014a). In 2011, just under two thirds of this was from forestry and logging activities, and a little over a third from wood processing – sawnwood, wood-based panels and pulp and paper (*ibid*). The formal sector employs about 650 thousand people constituting just 0.2 per cent of the labour force (*ibid*). While the value of production of the formal forest sector in Africa has been growing in real terms since 1990, its relative monetary importance in African economies has been declining, reflecting the rise of other sectors such as minerals extraction. In 1990, the formal forest sector contributed 1.7 per cent of GDP in Africa (2.2 per cent of GDP in Sub-Saharan Africa), but this declined to 1.3 per cent in 2006 and further still to 0.9 per cent in 2011 (Lebedys, 2008; FAO, 2014a) [1]. Nevertheless this masks considerable regional variation with contribution to GDP being as high as 15 per cent in Liberia (FAO, 2014a) while in

[1] This trend is not peculiar to Africa as can be seen from the global level statistics. In 2006, the forest sector contributed 1 per cent to world GDP (FAO 2009) but by 2011 its share had declined to 0.9 per cent (FAO 2014a).

Cameroon, the formal forest sector made a greater contribution to GDP and to public revenue in 2008-2010 than the mining sector (excluding oil) (Nkou and Eba'a Atyi, 2013).

Value added processing has been increasing in Africa although it is still not very developed in comparison with other regions – According to ITTO (2012) domestic conversion of logs rose from 81 per cent in 2009 to 90 per cent in 2011, probably the result of log export restrictions that have been imposed recently in a number of African countries. However, ITC (2012a) considers that there has been a failure in Sub-Saharan Africa (SSA) to establish wood-processing industries, noting that in 31 SSA countries in 1995-2010, the value of imports of finished wood products increased by more than that of the imports of raw or partly processed wood based materials but with two notable exceptions: Ethiopia and Gabon which increased the shares of processed goods in their wood-based exports.

Production and consumption of all the major wood product categories (in volume terms) have grown considerably in Africa since 1961 but with some slowing down for production particularly after 2001, probably reflecting the effect of the global financial crisis (Table 1). Since 2008, there has been significant decline in production for all of the product categories shown except sawnwood, and declines or only small increases in consumption of all four product categories.

Table 1 Production and consumption of wood products in Africa

Product	Amount (million m^3) or tonnes			
	1961	1981	2001	2013
Production				
Industrial roundwood*	24.7	51.0	68.9	69.3
Sawnwood	2.9	8.0	7.6	9.1
Wood-based panels	0.3	1.5	2.7	2.7
Paper and board (tonnes)	0.4	1.9	3.7	3.5
Consumption				
Industrial roundwood*	20.2	46.9	64.4	66.0
Sawnwood	3.9	10.8	10.8	16.3
Wood-based panels	0.2	1.8	2.9	4.3
Paper and board (tonnes)	0.8	2.9	4.9	6.9

*Sawlogs and veneer logs, pulpwood and other industrial roundwood
Source: Own elaboration with statistics extracted from FAOSTAT September 2014.

Exports of wood products: significant but declining relative to other sectors[2]

Exports of forest products from Africa were just over US$ 5 billion in 2011 with three African countries (South Africa, Cameroon, and Gabon) making significant contributions. All three had exports and net exports (exports minus imports) of more than US$ 0.5 billion in 2012 (FAO, 2012a). However, as with production, the relative significance of wood exports is declining. The share of wood products of all SSA exports in value terms declined in the period 1995 to 2010 from 2.5 per

[2] All figures in this section are taken or calculated from FAO (2012a) except where otherwise stated.

cent to 0.8 per cent for wood and wood-based articles and from 1.3 per cent to 0.8 per cent for wood pulp and articles thereof (ITC, 2012a).

In volume terms, the share of exports of wood products in total production in Africa in 2013 ranged from 6 per cent in the case of lumber (wood in the rough) to 20 per cent for wood-based panels and 23 per cent for sawnwood. **African countries make significant contributions to world trade in wood products but primarily for the least processed types of product**. Exports of tropical non-coniferous logs by the nine African countries included by FAO (2012a) in the world's top fifteen exporters of such logs corresponded to approximately 14 per cent of world trade in this product in 2012. Similarly, non-coniferous sawnwood is an important African export with three African countries (Cameroon, Gabon and Cote d'Ivoire) included in the top 15 exporting countries with exports equating to just fewer than 8 per cent of world trade in this product in 2012.

High and increasing dependence on imports of wood products[3]

Import dependence is currently very high. In 2011, the value of forest products imports to Africa was over US$8.5 billion equal to more than half of gross value added (US$16.56 billion) in the forest sector that year (FAO, 2014a) and significantly higher than exports of forest products from Africa (US$ 5.1 billion in 2011). Most of this trade gap was due to large imports made by North African countries but there are a number of countries in other sub-regions that are also net importers though with considerably small gaps, notably Nigeria, Ethiopia and Kenya. South Africa is the largest importer of forest products in both value and volume terms in the region after the North African countries. **These major African importing countries are mainly sourcing their wood and fibre from outside Africa,** from Malaysia for non-coniferous sawnwood, from Russia and China for plywood, and wood pulp from USA, Finland and Indonesia. The exceptions are veneer sheets mainly imported from Gabon.

The informal sector is a key player in wood harvesting and processing

Statistics on the formal forest sector give an incomplete picture of the contribution of wood harvesting and processing to African economies as the informal forest sector is highly significant both in economic terms and for its livelihood benefits. Small-scale logging and sawmilling carried out on an informal (and sometimes illegal, though not always illegitimate[4]) basis often provide many more jobs than the formal forestry sector, in the case of Cameroon by a factor of two (22,000 jobs in the formal forest sector versus 44,000 jobs in artisanal sawmilling) (Eba'a Atyi *et al*., 2013).

[3] All figures in this section are taken or calculated from FAO (2012a) except where otherwise stated.

[4] Where formal private or government ownership of forest resources overlaps with traditional or customary rights to such resources, exploitation of these resources by local communities may be outside of formal law but in accordance with customary rules and hence not necessarily illegitimate or unsustainable.

2.2.3 Wood is primarily used as an energy source in Africa

The major part of Africa's roundwood production and consumption, some 90 per cent, is not for timber but for woodfuel[5], that is for fuelwood and charcoal[6]. FAO (2014a) estimates for 2011 that a total of just under 660 million people in Africa used either wood or charcoal for cooking, 63 per cent of the total population, 77 per cent of rural households and 43 per cent of urban households. Woodfuel is also an important energy source for service sector for cooking and for the industrial sector for brick, tile and ceramics drying, tobacco curing amongst others (ASCPF, 2013).

Although there have been efforts to extend electrification, for example in South Africa, these have not been able to keep pace with population increase. Even where electricity is available, low and middle income households often continue to use traditional biomass for cooking because of its relative low cost (ASCPF, 2013). As a result, **Africa is a significant global producer of wood energy, responsible for 60 per cent of global charcoal production and 34 per cent of global wood fuel production in 2012 (FAO, 2012b).**

Most fuelwood is used for subsistence but is commercially traded in urban areas in some countries, such as Botswana, Burkina Faso and Chad (ASCPF, 2013). In contrast, most charcoal is produced not for subsistence but to be marketed and the charcoal industry in Africa was estimated to be worth US$10.6 billion in 2011 (FAO, 2014a). Recorded/official international trade in charcoal is tiny compared to the estimates of production and consumption but there is some illegal trade in charcoal in East Africa between Kenya, Tanzania and Uganda and also in West Africa, driven mainly by contradictory policies and price disparities (ASCPF, 2013). According to estimates in FAO (2014a), the addition of **income from informal production of charcoal and collection of fuelwood for urban markets at least doubles the contribution of the forest sector to GDP** in Africa to 2 per cent and adds another 19 million full-time equivalent (FTE) jobs in the sector (of which 14 million FTE are for charcoal) increasing the sector's contribution to employment to 4.8 per cent. On this basis, FAO (2014a) concludes that the main socioeconomic benefit provided by forests in Africa is the production of energy rather than wood products.

There are concerns though about the nature of employment in the woodfuel sector, in charcoal production particularly. As charcoal production is considered illegal in many African countries, much of the sector operates clandestinely, making it difficult to ensure that those engaged in wood collection and charcoal production receive a fair return and that working conditions are safe (ASCPF 2013). Other social concerns relate to the health impacts of indoor air pollution

[5] Wood fuel is defined here as roundwood that is used as fuel for purposes such as cooking, heating or power production and includes wood used to make charcoal. The percentage figure and definition of woodfuel are from FAO (2012b).

[6] Statistics on woodfuel should be treated with caution as few countries report wood fuel and charcoal production systematically so for most countries in Africa are based on estimates (ASCPF, 2013). FAO estimates of wood fuel and charcoal consumption are based on a statistical model relating wood fuel and charcoal consumption to a number of variables including population, income, forest cover, oil production, temperature, and land area (FAO, 2012a).

from the use of fuelwood and charcoal stoves, and the large amount of time spent usually by women and young girls to collect fuelwood (World Bank 2012).

2.2.4 Non-wood forest products are important for livelihoods and for commercial trade

Numerous case studies in specific locations have shown the importance of non-wood forest products (NWFPs), both marketed and non-marketed, for people's livelihoods in Africa with wild foods and fodder for animals being important uses after fuelwood (e.g. Vedeld et al., 2004; Gumbo, 2010). Estimates from FAO (2014a) show the commercial importance of NWFPs, with an estimated gross production value in Africa in 2011 of US$5.3 billion, representing 0.3 per cent of GDP for the region[7]. These estimates focused on medicinal plants, and a selection of animal-based NWFPs (bushmeat, and honey) and plant-based NWFPs e.g. sheanuts, natural gum, and natural rubber.

There is little regional level information on employment in NWFPs. Case studies of specific products however, can give an idea of the importance of NWFPs. *Prunus africana*, the bark of which is an important raw material for the pharmaceutical industry, has a value chain in Cameroon, involving at least 60,000 people in communities with community forests, plus individuals with plantations, about 500 harvesters, 11 exploitation permit-holding small scale enterprises and approximately five exporting enterprises (Nsawir and Ingram, 2007).

While marketed NWFPs can provide income and employment for rural populations, there are similar concerns as for woodfuel about exploitative working conditions and low returns to collectors. In some cases this is because harvesting is illegal and in others due to lack of information and bargaining power on the part of collectors (Gumbo, 2010).

2.2.5 Ecosystem services

Forest ecosystem services (ES) play critical, but under-reported, roles in local economies and livelihoods. In addition to the provisioning ES discussed above, there are ES which provide regulating, supporting, and cultural benefits that are important for almost every sector and every livelihood. Forests play a vital role in sustaining Africa's biodiversity. For example forests are vital habitats for African apes all species of which are on the IUCN Red List of Endangered or Critically Endangered Species (Morgan et al., 2013). Nature-based tourism is a major economic activity in Africa, particularly in Sub-Saharan Africa. In the Great Lakes Region, revenue from tourism based on gorilla viewing and other activities brings in about US$20 million annually but human costs associated with tourism such as displacement of communities need also to be considered (Gumbo, 2010). A number of studies in different locations, the Virunga and Bwindi afro-montane forests of Eastern and Central Africa (Hatfield and Malleret-King 2004), and the Mt Kenya National Park (Emerton, 1998) have shown that there are significant global and national scale biodiversity benefits of forests in protected areas but

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[7] This estimate is uncertain due to difficulties in distinguishing between products collected from forests and those cultivated in agricultural areas, and lack of data in many countries, on costs particularly (FAO 2014a).

that there are costs to local communities (UNEP, 2012). Many communities also benefit from the diversity and forest ecosystem services.

Other important services provided by forests in Africa are in protecting watersheds and regulating climate. Forest cover is important for maintaining good water quality by minimising soil erosion, regulating flow, and providing protection from floods. These have significant implications for the economy. It has been estimated for example, that deforestation of montane forests in Kenya in 2009 and 2010 led to losses to irrigation agriculture, fishing, hydropower and water supply that far exceeded gains from logging (UNEP, 2012). African forests store significant amounts of carbon but **the loss of forest cover and the degradation of forest resources means that African forests are no longer net sinks of carbon but are a major source of emissions.** Emissions from land use change are estimated at 0.32 Pg C/year ± 0.05 Pg C/year (2000-2009) mostly resulting from deforestation for cropland, and for shifting cultivation (Valentini *et al.*, 2014).

2.3. Threats to the green economy contribution of forests in Africa

The ability of the forest sector to contribute to green economy objectives in Africa is threatened by changes in the forest resource base, the result of pressures within the sector and from other sectors as well as market, policy and governance failures. A key issue is the unclear and overlapping rights to forest resources. Most of the forests in Africa are formally under state ownership with relatively small areas of private ownership and formally recognised community management, the latter corresponding to barely 1 per cent of total forest area in Sub-Saharan Africa in 2010 although this had increased from previous assessments (FAO, 2010a). Informal rights associated with traditional systems of governance are rarely given recognition by government authorities. As a result local communities often have little incentive to invest in forests, and if they harvest forest resources are considered to be doing so illegally.

Devolution of management rights to communities has taken place in some areas in Eastern and Southern Africa (FAO, 2010a). More recent reports on the Congo Basin indicate that community management is taking place in Central Africa, particularly Cameroon (Bayol *et al.,* 2014).

2.3.1 Deforestation

Africa has lost a large area of forest over the last two decades, some 75 million hectares between 1990 and 2010) with an average deforestation rate of 0.5 per cent per year over the last 10 years but with considerable variation between countries (FAO, 2010a). Ghana, for example lost 135,000 ha per year or 1.99 per cent while Kenya's deforestation rate was less than average at 0.35 per cent. Much of the loss of forest cover to date in Africa can be attributed as much to pressures from competing land uses, agriculture in particular, as to the wood removals associated with the demand for industrial roundwood and wood fuel, although they often occur together or in sequence as logging and the expansion of infrastructure facilitates access (Geist and Lambin, 2002; Chomitz *et al.,* 2006). Moreover, wood fuel harvesting can sometimes generate the income needed to finance alternative land uses (Arnold *et al.*, 2003). For example in West Africa, the sale of woodfuel from clearance of forests has helped young and migrant farmers to establish new farms in the forest zone (Arnold *et al.*, 2011).

2.3.2 Over-harvesting and unsustainable forest management

Logging

Forest degradation associated with logging is also a *concern* both for the future of the timber industry and for the impact on other forest uses and ecosystem services. Logging has been taking place for over a hundred years in Africa and large areas of forest, particularly in West Africa have been logged several times (Rietbergen, 1989; Blaser *et al.,* 2011). While harvesting intensity is relatively low in African logging concessions, typically $10m^3$ to $40m^3$ per hectare (Dupuy *et al.,* 1999), early re-entry is common and rotations have been getting shorter in duration. At the same time there is a lot of pressure from informal or illegal logging. In Ghana, the timber harvest was estimated by Mayers *et al.* (2008) to be several times more than the annual allowable cut (AAC) established by the Forestry Commission. This was because the formal sector operators were cutting more than they were allowed to by their contracts and because informal/illegal operators were extracting timber without regulation. Ghana's wood processing capacity also greatly exceeds the AAC set by the government (Marfo, 2010) and the Emission Reduction Project Idea Note (ER PIN) prepared for the Carbon Fund of the Forest Carbon Partnership Facility (FCPF) claims that the country has seen timber revenue decline by nearly 30 per cent since 2009, reflecting the threat to forests from multiple drivers (FCPF, 2014). The result of this long standing exploitation of forests in some countries in Africa (West Africa particularly), is that supply constraints are being experienced and the industry has declined as a result (Blaser *et al.*, 2011).

In other areas, particularly in Central Africa, the volume of timber harvests may be well below the potential sustained yield but the problem is the lack of sustainable forest management which would ensure that conflicts with the provision of other ecosystem services and of local livelihood benefits would be kept to a minimum**.** In November 2014, the area of forest certified to Forest Stewardship Council (FSC) standards was 5.67 million hectares (FSC, 2014). This included about 1.5 million hectares of forest plantation in South Africa but also over 3.5 million hectares of natural forest in Cameroon, Congo and Gabon (*ibid*). However, this is still only a tiny proportion of the forest production area. The most recent ITTO survey of forest management in member countries (Blaser *et al*., 2011) which employed a broader set of criteria for sustainable forest management gives a more promising picture. It estimated that in 2010 in the ten African ITTO member countries there were 68.2 million hectares of natural forest production permanent forest estate of which 6.56 million ha or 9.6 per cent could be considered as sustainably managed, up from 4.3 million (or 6 per cent) in 2005. Based on the data above we conclude that **only a small proportion of Africa's production forests can be considered sustainably managed, although there has been some improvement over the last decade.**

Woodfuel harvesting leading to localised pressures

The large amounts of woodfuel extracted each year are thought by some to be a threat to sustainability but there are different views. Estimates made by Openshaw (2011) of annual yield in Sub-Saharan Africa in 2006 based on data in FAO (2010a) indicate that there is an accessible annual yield of 4.5 billion m^3 of wood biomass from forests, other wooded areas, and farms and grassland, considerably higher than estimated demand. However, the challenge is that while there may be an overall surplus at a regional level, specific locations, large urban areas in particular, may not be supplied from sustainable sources (ASCPF, 2013). Research in Malawi cited by ASCPF (2013) shows that the woodfuel catchment areas of four principal towns expanded considerably between 1993 and 2007 to meet increased urban demand and in the case of Blantyre, demand was becoming close to exceeding sustainable yield. Hofstad *et al.* (2009) cite research on miombo woodland in Tanzania (Luoga *et al.*, 2002) where annual removals of 6.38 m^3 per hectare exceeded the mean annual increment of 4.35 m^3/ha.

NWFPs threatened by deforestation, degradation and over-harvesting

The concerns about depletion of resources apply also to NWFPs. These are threatened by deforestation but also by over-harvesting. There are numerous examples of NWFPs that have been important marketed products but have seen wild populations' availability decline considerably because of over-harvesting or inappropriate harvesting techniques. Examples include *Prunus africana* in Cameroon (Nsawir and Ingram, 2007).

2.4 Business as usual scenarios

2.4.1 Scope and approach

This section looks ahead to 2030 and 2050, and considers the likely outcome for forests in Africa and their contribution to green economy objectives if no major changes are made in policy both in the forest sector, and in other areas such as agriculture, energy and climate change policy which have implications for forests. It examines likely developments in the demand for forest products, focusing on two major categories industrial roundwood the products derived from it – sawnwood, wood-based panels, pulp and paper and woodfuel - fuelwood and charcoal[8]. The aim is to determine the amount of wood that needs to be extracted from the forests to meet future demand and to consider whether the forest resource base can support such a level of extraction sustainably, given other pressures such as the demand for land from agriculture, and other developments such as the availability of resources from planted forests. Key issues are the implications for employment and value added and the impact this pressure on forest resources will have on the other forest ecosystem services.

Predicting what will happen 30-40 years into the future for a sector with such a complex range of influences is fraught with difficulties. Wide differences exist in available projections as well as in estimates of key indicators of the current situation. Our approach is to determine the trend over recent decades, and examine influencing factors to consider whether it is reasonable to assume that the historical trend will continue into the future. We also review projections made in previous studies to decide whether it would be appropriate to adopt these as indicative of the BaU scenario or whether some adjustments need to be made.

[8] While there are other important forest goods such as NWFPs and ecosystem services, there is insufficient data to make projections of demand.

2.4.2 Industrial roundwood demand

Domestic demand trends and drivers

Demand for wood-based products depends on population growth, GDP growth which is indicative of growth in personal incomes and in economic activities which use wood-based inputs, cultural factors which influence consumer preferences, prices of competing materials, and technology which affects the amount of wood removal required to deliver a wood-based product or service (e.g. boiling water). As incomes rise, people are likely to increase their use of wood and paper for buildings, furniture, printing and writing, packaging and sanitation. As incomes reach a certain level, typical of industrialised countries, the rate of growth of wood products demand slows down or stabilises because of substitution by other materials (FSC/Indufor, 2012). Population is expected to increase in Africa to 2.4 billion by 2050 according to the UN's medium estimate (UN, 2013) implying a compounded annual growth rate of 2.13 per cent between 2010 and 2050. Available projections are indicating high rates of economic growth for Africa, at least for Sub-Saharan Africa. IMF (2014) predicts that real GDP in SSA will grow at rates above 5 per cent from 2014 to 2019 while AfDB (2011) predicts that real GDP growth rates for Africa will remain above 5.0 per cent until 2060.

The high rates of growth of population and GDP projected for Africa over the next decades have led to predictions of substantial increase in demand for wood products. For example FSC/Indufor (2012) produce three scenarios of industrial roundwood demand based on different assumptions about responses of wood products consumption to population and GDP growth with growth rates to 2030; ranging from 1.4 per cent CAGR to 8.7 per cent but for 2030 to 2050 from 1.7 per cent to 5.4 per cent.

Business as usual projections for this report

The challenge for predicting demand for wood products and the implications for the amount of wood in the rough that needs to be removed from the forest is determining what is an appropriate or likely level of imports and exports as this has implications for domestic wood requirements and related impacts as well as for employment and value added generated by the sector. We therefore examine wood requirements in three situations:

- Continuation of the current import and export shares of consumption and production
- Domestic demand with full import substitution but no exports
- Domestic demand plus export demand.

Like previous projections e.g. FSC/Indufor (2012) we use roundwood equivalent (RWE) to enable the wood requirements for different categories of wood products to be added up[9]. Two simple approaches to projecting the production and consumption of industrial roundwood (RWE) to 2050 are taken here: extrapolation

[9] This is necessary because each category of wood products requires different amount of logs for their manufacture because of differences in recovery rates.

of past demand trends; and constant per capita consumption of wood products. These imply rates of growth that lie between Indufor's Scenarios 1 and 2.

Extrapolation of past demand trends[10]: BaU Scenario 1 is based on the 1961-2010 RWE consumption growth rate of 2.92 per cent CAGR[11]. This is higher than average RWE growth rates over the last thirty years. However, the first few years of the new millennium before the financial crisis saw annual growth rates exceeding 4 per cent as did the twenty years up to 1981. In the next forty years, Africa is expected to have lower population growth than in the previous five decades but higher real GDP growth such that real GDP per capita could increase by 3 per cent or more per year. In view of this, it seems plausible that Africa could see a similar growth rate in roundwood consumption (RWE) over the next forty years to that experienced over the last 50 years. This would allow for some modest increase in per capita consumption with growing GDP, but also some substitution by other materials.

Constant per capita consumption of wood products: BaU Scenario 2 like Indufor's Scenario 1 assumes that per capita consumption of wood products (RWE) will remain constant and will not increase with real GDP growth. Substitution of wood and fibre by other materials as incomes rise is assumed to be more extensive counteracting the effects of GDP growth. Total consumption in the region would therefore grow at the same rate as population.

The projections in Table 2 indicate that demand for wood could be two or even three times the 2010 level by 2050, assuming that the current pattern of imports and exports is maintained, and considerably higher if attempts were made to increase exports or substitute imports.

Table 2 Projections for industrial roundwood production and consumption million m^3 (RWE)

	Scenario 1 - Consumption grows at same rate as 1961-2013			Scenario 2 – Constant per capita consumption		
	Production million m^3	Consumption million m^3 RWE	Consumption plus exports mn m^3 RWE	Production Million m^3	Consumption million m^3 RWE	Consumption plus exports mn m^3 RWE
Base year 2010	71.0	96.2	113.5	71.0	96.2	113.5
2030	126.2	171.1	201.8	108.1	146.6	172.9
2050	224.3	304.4	359.03	164.7	223.3	263.4

Source: Own calculations based on FAOSTAT figures for production, imports and exports.

[10] RWE growth rates estimated by the authors from FAOSTAT data extracted September 2014.

[11] 2010 is used as the base year to line up with deforestation data. As production and consumption of industrial roundwood in Africa have declined since 2008, this gives higher projections than if 2013 were used.

2.4.3 Woodfuel

Recent trends

Woodfuel production and consumption in Africa have grown at an annual rate of 1.84 per cent between 1961 and 2013, at a somewhat lower rate of 1.4 per cent since 2001, and lower still at 1.17 per cent from 2008. Production of charcoal, which is an increasingly important constituent of woodfuel, is estimated to have grown at more than double the rate for wood fuel at 3.33 per cent per year (CAGR) between 2001 and 2013. This trend reflects rising incomes but also urbanisation. As rural people move to urban areas they tend to switch from collecting or buying firewood to buying charcoal. For many low and middle income households in urban areas in SSA, charcoal provides a reliable, convenient, accessible and affordable source of energy (ASCPF, 2013).

The number of people dependent on traditional biomass has increased over time – in 2004 it was estimated at 579 million for Africa (575 million in SSA) and projected to grow to 627 million in SSA by 2015 (IEA 2006 cited in World Bank 2012) but by 2010 it had already exceeded this forecast, reaching 698 million (IEA, 2012). Woodfuel consumption is likely to increase as population increases. Even though the rate of population increase in the period to 2050 is not expected to be as high as in previous decades, the increasing urbanisation will offset this, as it will intensify a switch from fuelwood to charcoal, implying greater resource requirements. This trend is likely to continue as urbanisation in SSA gathers momentum. Africa is urbanising faster than in the late 1990s and is expected to be the fastest urbanising region from 2020 to 2050. The urban population in Africa in 2014 was 40 per cent and is projected to increase to 56 per cent by 2050 (UN, 2014).

Business as usual projections of woodfuel demand in volume terms

For projecting Africa's woodfuel demand to 2050, two approaches have been taken here. The first BaU scenario is based on IEA (2012) projections for its New Policies Scenario (encompassing governments' declared policy intentions as well as existing policies) which forecasts growth in the number of people dependent on traditional biomass for cooking to 886 million by 2030 although the share of total population will decline. 40 per cent of this growth will be in urban areas. We use the growth rates of the number of traditional biomass users in rural and urban areas in IEA's projections to 2030 to estimate the number of wood fuel users in 2030 and extrapolate further to 2050. This gives 1.06 billion woodfuel users in 2050 and assuming consumption per user for woodfuel and charcoal remain the same as in 2011, a total consumption of 1.05 billion m^3 (Table 3).

The second BaU scenario does not encompass any new policies and is based solely on expected population growth and urbanisation. It assumes that the average amount of fuelwood or charcoal per user does not change, nor do the percentage shares of woodfuel users of urban populations and of rural populations. However, the proportion of wood fuel users in the total population declines slightly because of urbanisation. It thus represents an upper bound for wood fuel consumption in 2050. The result is an increase in consumption to 1.4 billion m^3 and an increase in the number of users of woodfuel to roughly 1.4 billion.

Table 3 BaU projections of woodfuel users and consumption

Consumption and users of woodfuel	Base year 2011	BaU Scenario 1		BaU Scenario 2	
		2030	2050	2030	2050
Fuelwood urban (mn m^3)	83.7	117.3	167.5	156.6	269.4
Fuelwood rural (mn m^3)	381.3	458.5	556.8	523.1	643.9
Total fuelwood (mn m^3)	465.0	575.9	724.3	679.7	913.3
Charcoal urban (mn m^3)	132.6	186.0	265.6	246.6	424.4
Charcoal rural (mn m^3)	41.6	50.0	60.7	57.0	70.2
Total Charcoal (mn m^3)	174.2	236.0	326.3	303.6	494.6
Total Woodfuel (mn m^3)	639.2	811.9	1,050.6	983.3	1,407.8
No. of woodfuel users (millions)	659.6	821.4	1,060.5	993.70	1,387.1
Woodfuel users as per cent of total population	63 per cent	51 per cent	44 per cent	61 per cent	58 per cent

Source: Base year: FAO (2014a) Scenarios: own calculations data in FAO (2014a), IEA (2012), FAOSTAT, UN (2013), UN (2014)

2.4.4 Outlook for supply and the forest resource base

The preceding sections have suggested that there will be a significant increase in demand for wood products and for woodfuel in Africa over the next 15 and 35 years. Whether it will be possible for Africa's forests to meet this demand without further depletion of the natural resource base and compromising delivery of other ecosystem services will depend on a number of factors including policy change in both the forest sector and other sectors such as energy and agriculture. Here we focus on the following factors:

- Extra-sectoral pressures which drive deforestation for agriculture or infrastructure
- How much production can be expected from planted forests/plantations /and extent to which these are sustainably managed
- How logging is carried out – on a conventional basis or on a sustainable basis

Projections for deforestation

If forest loss continues at the same rate in Africa as in the last ten years (0.5 per cent per year) this will result in a loss of 64 million ha of forest by 2030 and 122 million ha by 2050. Estimates in the literature are more pessimistic, predicting a large increase in the deforestation rate. The Living Forests report (WWF, 2012) predicts that Africa will lose 112 million ha of forest cover by 2030 implying a deforestation rate of 0.9 per cent per year. Hilderink *et al.* (2012) predict a 29 per cent loss of forest by 2030, implying deforestation of 195 million ha and a yearly rate of 1.69 per cent[12].

[12] Assuming that the projections are based on FAO forest statistics. Unfortunately, neither of these two reports provides any explanation of how they arrived at these figures.

The outlook for forest cover depends to a great extent on the outlook for agricultural demand and supply in Africa as this will affect the demand for agricultural land. Increasing population, increasing incomes and shifts in tastes to more meat-based diets are forecast to increase the demand for food in Africa considerably. Alexandratos and Bruinsma (2012) project a growth in total world consumption of all agricultural products of 1.1 per cent per year from 2005/7 to 2050. This equates to a 60 per cent increase in value terms in global production in 2050 compared with that of 2005/2007 - 77 per cent in developing countries and 24 per cent in developed countries. In calorie terms it equates to a 54 per cent increase. To meet this demand, agricultural production in SSA is expected to triple by 2050 although annual rates of growth would be lower than in previous decades 2.5 per cent per year from 2005-07 to 2030 and 2.1 per cent from 2030 to 2050 compared with rates exceeding 3 per cent between 1987 and 2007 (*ibid*).

These authors estimate that 31 per cent of the increase in production achieved in the period 1961-2007 could be attributed to expansion of cultivated land, 31 per cent from increase in cropping intensity and 38 per cent for yield increase. If land expansion's percentage contribution to increased production were to remain at the same level of previous decades, i.e. 31 per cent, the amount of land required would be 85 million ha. Other studies (Valin *et al.*, 2014) have forecast somewhat higher increases in global food demand, suggesting that FAO'S projected 60 per cent increase in world agricultural production value might need to be 20-30 per cent higher. If this were the case in Africa, the amount of additional land required by 2050 would be 102-110 million ha. This would be close to the estimates of deforestation based on past trends[13]. For these reasons we base one BaU scenario for deforestation on past trends.

For land requirements to come anywhere near to the WWF and Hilderink *et al.* (2012) estimates of deforestation, it would be necessary to predict that the contribution of increased yields and cropping intensity to growth in production will be considerably lower than in previous decades and/or that there are other influences such as adverse impacts of climate change on crop yields and pressures on land from non-food crops such as biofuels. Alexandratos and Bruinsma (2012) acknowledge that their scenarios are 'limited biofuels' scenarios with projections of feedstocks only to 2019 and that they are based on present climatic conditions. It is possible therefore that land requirements for agriculture could be significantly higher if higher temperatures and greater variability of rainfall associated with climate change lead to reduced yields. For this reason we take the deforestation rate of 0.9 per cent implicit in the Living Forest Report (WWF, 2012) as an alternative BaU scenario for deforestation. This would lead to forest loss of 112 million hectares by 2030 and 205 million by 2050.

2.4.5 Projections for planted forests

Review of previous assessments and projections

The area of planted forest in Africa has expanded fairly rapidly over the last decade with average annual growth of 1.75 per cent (FAO, 2010a). However,

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[13] This assumes a worst case scenario that all additional land for food production involves deforestation even though Alexandratos and Bruinsma (2012) consider there to be sufficient non-forest land available for this.

much of the expansion has been in planted forests established for protective purposes for example to prevent erosion/protect watersheds or in multipurpose plantations to provide woodfuel and other local wood materials. The area that is dedicated to industrial roundwood in high yield, intensively managed forest plantations is believed to be considerably smaller, some 4 or 5 million ha, although estimates vary. A recent assessment of the volume of industrial roundwood produced from forest plantations estimates that 21 countries in Africa between them produced 26 million m^3 in 2012 (Jürgensen *et al.*, 2014. This is considerably lower than some earlier estimates (e.g. GEF, 2013 and Carle and Holmgren, 2008), implying a smaller plantation area or lower productivity than assumed in earlier studies.

Business as Usual projections for this report

Since the estimate in Jürgensen *et al.* (2014) is the most recent and the most extensive in its coverage of Africa it is used here with a small adjustment (+8.67 per cent) to take account of the production from African countries not included in the study[14]. This gives 28.25 million m^3. Applying the growth rate due to productivity increase in Carle and Holmgren's BaU scenario, the production of industrial roundwood from forest plantations in 2050 is estimated at 33 million m^3 (Table 4). Taking a less pessimistic view of the scope for expansion of planted forest land area and assuming a modest expansion of 0.4 per cent per year results in a slight increase to just less than 39 million m^3 by 2050.

Table 4 BaU projections of industrial roundwood supply from planted forests in Africa

Scenario assumptions	Industrial roundwood production (million m^3)		
	Base year	2030	2050
Productivity growth of 0.4 per cent per year (Carle and Holmgren 2008)	28.25	30.45	33.08
Productivity growth of 0.4 per cent per year (Carle and Holmgren 2008) and modest expansion of area at 0.4 per cent per year	28.2	32.80	38.71

Source: own calculations

2.4.6 How logging is carried out - harvesting intensity

Sustained yield

A commonly cited figure for mean annual increment (MAI) from a well-managed tropical forest is 1 m^3/ha (e.g. Blaser *et al*., 2011; GEF, 2013). The appropriateness of using this 1 m^3 MAI as an indicator of AAC /sustained yield has been questioned though because of the need to consider residual logging damage and within tree waste. Alder (1999) argues that when these two factors are taken into account, a MAI of 1 m^3 will in practice work out as an annual

[14] Several of these countries, in particular, Angola, Madagascar, Tunisia and Senegal, reported areas of productive plantation exceeding 100,000 ha in the 2005 Forest Resource Assessment (Del Lungo et al. 2006) and nearly one million ha of productive plantation in total. This equates to 8.67 per cent of the productive plantation area in 2005.

allowable cut (AAC) of 0.25 to 0.5 m^3/ha, measured as logs at the landing roadside. This appears consistent with data given by Rougier, one of the major FSC certified timber harvesting and processing companies in Central Africa, which manages more than 2 million ha of forestry concessions in Gabon, Cameroon and the Republic of Congo (Rougier and Clement, 2012). From Rougier's forest area and production figures in each of the three countries an average annual commercial volume can be derived of 0.19 m^3/ha/year in the Republic of Congo, 0.3 m^3/ha/year in Gabon and 0.36 m^3/ha/year in Cameroon[15].

Harvesting intensity required to meet projected industrial roundwood demand

Taking demand for industrial roundwood in Africa as a whole, the area of natural forest designated for production[16], and the amount of production expected from planted forests, **it can be calculated that the average amount of wood removed per ha per year would need to be 0.35m^3 to meet current domestic demand with full import substitution (Table 5). This is within the range for AAC on a sustained yield basis in Adler 1999/2001. With the current level of imports and exports, the average amount of wood needed per ha per year would be somewhat lower at 0.22 m^3.** It could therefore be concluded that wood production at the current level could in theory be sustained from the current area of forest designated for industrial production, if it can be assumed that the existing production PFE is not already depleted below sustained yield levels. There are considerable variations between and within countries. There is also a large amount of informal or illegal production that does not get captured in official statistics. Some of this takes place outside the production PFE but in some cases it targets the industrial concessions (e.g. Ghana (Marfo, 2010).

With the projected increases in demand under BaU combined with cumulative loss of production forest area due to deforestation, harvesting intensity would have to increase considerably if demand is to be met from the production PFE. Table 5 shows that for both BaU scenarios, harvesting intensity would have to increase well beyond the range indicated by Alder *et al.* (1999) as indicative of sustained yield. **To meet projected domestic demand in 2030, it would have to be double the sustained yield level, and three or four times this level to meet demand in 2050.** If the current share of imports and exports is maintained into the future, harvesting intensity could be lower but would still be above Alder's range (0.25 to 0.5m^3/ha/year). If harvesting intensity increases in the intervening years, then the forest resources in the production PFE may become so depleted that this sustained yield range may no longer be appropriate.

These calculations also depend heavily on the assumptions made about where deforestation occurs. Table 16 is based on an assumption that deforestation in the production PFE will be in line with the share of this type of forests in all non-

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15 http://www.rougier.fr/en/rougier-afrique-international/485-sfid-societe-forestiere-et-industrielle-de-doume-doume-forestry Congo: 586,000 ha of forests in operation, producing around 110,000 $m^3$of logs per year equivalent to 0.1877 m^3 per hectare per year. Cameroon: 550,000 ha of forest and producing 200,000 m^3 of logs per year (equivalent to 0.36 m^3/ha/year).

16 The area of natural and planted forest designated for production in Africa is 205 million ha (FAO 2010b). Of this about 11.5 million ha is planted forest for productive purposes (75 per cent of 15.4 mn ha of planted forest). This means that the area of natural forest PFE for industrial roundwood production is 193.5 million ha.

protected forests. If instead it is assumed that 90 per cent of deforestation takes place in the production PFE the harvesting intensity required to meet domestic demand in 2050 increases to 2m^3/ha and 25 m^3/ha in the two BaU scenarios.

Table 5 Business as usual projections for supply/resource base for industrial roundwood

Demand and supply indicators	Current	2030		2050	
With domestic demand - full import substitution but no exports		Low demand high supply	High demand low supply	Low demand high supply	High demand low supply
Total area of forest (mn ha) A	674.419				
Area of forest in protected areas mn ha B	83.2				
Area of non-protected forest mn ha C (A-B)	591.219				
Natural forest production PFE mn ha D	193.5				
Cumulative forest loss from base year mn ha E		64	112	122	204
Cumulative forest loss in natural forest production PFE mn ha F (E*D/C)		21.1	36.5	39.9	66.8
Natural forest production PFE after deforestation mn ha G (D-F)	193.5	172.4	157.0	153.6	126.7
Industrial roundwood domestic demand (mn m3/year) L	96.2	146.6	171.1	206	304
Planted forest mn m3/year J	28.25	32.8	30.45	38.71	33.08
Production that has to come from natural forests PFE N (L-J)	68.0	113.8	140.7	167.3	271.3
Harvesting intensity/yield per ha required to meet demand m3/ha N/G	***0.35***	***0.66***	***0.90***	***1.09***	***2.14***
With current share of imports and exports maintained					
Production that has to come from natural forests PFE N (L-J)	42.7	75.3	95.8	126.0	191.4
Harvesting intensity/yield per ha required to meet demand m3/ha N/G	***0.22***	***0.44***	***0.61***	***0.82***	***1.51***
Domestic demand plus current share of exports maintained					
Production that has to come from natural forests PFE N (L-J)	85.2	140.1	171.4	224.7	325.9
Harvesting intensity/yield per ha required to meet demand m3/ha N/G	***0.44***	***0.81***	***1.09***	***1.46***	***2.57***

Source: Own calculations with data from FAOSTAT and FAO (201

2.5. Impacts of business as usual

2.5.1 Value added and employment in business as usual

Formal forest sector

As domestic demand for wood products in Africa is projected to grow at a lower rate than GDP, it is highly likely that the formal forest sector, while growing in absolute terms, will continue to decline in importance relative to other sectors of the economy in terms of percentage contribution to GDP and share of the labour force. Factors that might work against this would be a significant increase in the extent of secondary processing and/or an increase in exports both of which would greatly increase employment and value added per m^3 of production. However, the absolute growth in value added and employment will also be dependent on the sustained supply of industrial roundwood. The estimates shown in Table 5 suggest that obtaining the amount of timber needed to meet growing demand will become increasingly difficult as harvesting intensities increase beyond the level of sustained yield. If the response is a cutback in exports, and increasing replacement of domestic production by imports, the formal forest sector will further lose its economic importance.

Jobs in woodfuel

The projections of woodfuel demand show that it is likely to retain its social and economic importance in the future, providing an important source of energy for at least one billion people in Africa by 2050, corresponding to over 40 per cent of the population and possibly over 50 per cent. As urban consumption of woodfuel, and charcoal in particular, increases, employment can be expected to expand. Using the methodology in FAO (2014a) we have made projections of informal employment in the production of charcoal in both urban and rural areas and the production of fuelwood for urban areas [17]. Table 6 presents the estimates, showing that employment in woodfuel and charcoal could range between 34 million and 54 million FTE by 2050, representing an important share of the labour force.

[17] Following FAO (2014a) we assume that collection of fuelwood in rural areas is for subsistence and so does not generate employment, although providing important benefits. Estimates are based on the time to collect a m^3 of fuelwood (110 hours) or produce a kg of charcoal (0.19 hours) in Africa (FAO, 2014a).

Table 6 Informal employment in woodfuel and charcoal production under BaU

Employment Million FTE	Base year 2011	BaU Scenario 1		BaU Scenario 2	
		2030	2050	2030	2050
Urban woodfuel	4.9	6.9	9.8	9.2	15.8
Urban charcoal	11.2	14.0	20.0	18.6	32.0
Rural charcoal	2.9	3.8	4.6	4.3	5.3
Total	19.0	24.7	34.4	32.1	53.1
Share of labour force	4.6 per cent	4.9 per cent	4.7 per cent	6.3 per cent	6.8 per cent

Note: Rural woodfuel not included as assumed to be for subsistence rather than for sale.
Source: Base year: FAO (2014a) Projections: own calculations based on data in Table 11 and methodology in FAO (2014a)

2.5.2 Carbon emissions

Estimates of carbon emissions based on Valentini *et al.* (2014) and our projections of industrial roundwood demand, woodfuel demand, afforestation and deforestation are presented in Table 7. Despite the increase in industrial roundwood harvest, deforestation is projected to remain the major source of emissions from land use change and land use. Afforestation removals will still play only a minor role[18]. For woodfuel, it can be seen that the assumptions about the renewable sourcing of wood biomass influence the relative contribution of emissions from this source. If all charcoal, rural and urban is assumed to come from a non-renewable source, as well as all urban fuelwood, the emissions from woodfuel exceed those of industrial harvest. If only 10 per cent of woodfuel consumed is considered to be non-renewable, as in Habermeyl (2007), the net emissions are relatively insignificant.

2.5.3 Biodiversity

Recent studies on the biodiversity impact of logging have emphasised that the intensity of logging matters for its impact on different taxonomic groups. Burivalova *et al.* (2014) conclude that most animal groups are resilient to logging at intensities of less than 10 m^3 per hectare but in contrast an intensity of 38 m^3 per hectare would result in a halving of mammal species. Referring back to Table 5, the current average harvesting intensity of 0.22m^3/ha/year is well below this critical level assuming a 30 year rotation. By 2030 though, the harvesting intensity would increase beyond this critical level to 13.2 or 18.3 m^3/ha. By 2050, the harvesting intensity could reach 25m^3 to 45 m^3/ha, way above the critical level.

[18] Afforestation removals are estimated very conservatively in Valentini *et al*. (2014) to take account of replacement of natural forest by plantations and the impact of timber harvesting from mature plantations.

Table 7 Sources and sinks of carbon from land use change and land use in sub-Saharan Africa

	Average annual net flux of carbon TgC/year		
Land use change/use	Current (2000-2009)	2030	2050
Deforestation - to croplands, pasture, shifting cultivation	287	287-473	287-473
Afforestation*	(2)	(2.17-2.35)	(2.35-2.75)
Industrial harvest	38	57-86	65-119
Fuelwood harvest			
40 per cent non-renewable – urban fuelwood and charcoal and rural charcoal	121.8	154.7-187.4	200.2-268.3
10 per cent non-renewable	30.5	38.7-46.8	50.1-67.1

Source: Current emissions from Valentini *et al.* 2014 except for woodfuel (own estimates). Projections for 2030 and 2050: own estimates.

2.6 Conclusions

Africa's forests are closely linked with green economy in the region but their potential for green economy contribution is not being fully realised. There is considerable reliance on primary processing and little movement along the value chain. If no major policy changes are made, the formal forest sector will decline further as its natural resource foundation is further depleted. Reliance on timber imports will increase, adversely affecting jobs and value added. Deforestation driven by extra-sectoral demands will reduce the size of the productive forest area, and increase carbon emissions. Unsustainable harvesting levels driven by increasing demand will deplete forest resources, compromising future availability of timber and affecting other ecosystem services, biodiversity conservation in particular.

To address this situation it will be necessary to build the forest capital base, as well as the human/social capital to manage it; use this capital base more effectively and efficiently to improve wellbeing; alter demands on forests to protect ecological limits and the livelihoods of those dependent on forests.

The next chapter explores how this could be achieved through a series of green economy interventions.

3. Challenges and opportunities for building a green economy on forest ecosystem services and products

3.1. From business as usual to green economy

Instead of a declining forest sector with a precarious resource base as forecast in the previous chapter, a green economy approach has the potential to lead to a vibrant and innovative forest sector that can provide decent jobs and secure livelihoods – as well as ecosystem services that underpin so many growth sectors. A package of green economy interventions aimed at securing and enhancing the forest sector's natural capital base, could help to ensure that the growing levels of domestic demand for wood products projected for Africa in the future can be met, while enabling a world class export industry based on high value forest goods and services to become established. In particular it can maintain the important role of forest biomass as an energy source for the majority of the population, while making it less polluting.

So far there are numerous examples of promising green economy interventions in Africa but little hard evidence of their long-term impacts or replicability as they are so recent or so small-scale and in many cases have not been accompanied by a supportive enabling environment. Even where interventions are more long-standing, there can be different views about their degree of success in achieving their objectives and about their social and environmental impact. This applies particularly to plantation and tree planting projects. These green economy interventions can provide however, some glimpses of how the forest sector can contribute to social, environmental and development priorities as well as indicating the enabling conditions that will be needed to ensure that these green economy opportunities can be harnessed effectively.

This chapter reviews the different types of interventions that have been introduced in Africa in recent years and that can be considered as contributing to green economy. Drawing from experience of green economy interventions in six countries[19] and from more general literature, it reviews available evidence on their impact, considers their strengths and weaknesses, and draws lessons. This review is followed by some green economy scenario analysis of the implications of some of these interventions with a focus on two major uses of forest resources: timber and woodfuel.

3.2. Overview of green economy interventions

There are a number of opportunities for enhancing the forest sector's contribution to a green economy in Africa. Forest conservation is often considered as being in conflict with development. While there have certainly been examples of this, there are important opportunities to realise synergies between the sustainable

[19] These six countries were selected to give a good spread of regions and forest types in Sub-Saharan Africa.

management of forests and national development through adoption of a green economy approach. For all these interventions to be considered part of a green economy, they need to be both environmentally and socially sound, in line with the vision set out in the introduction. Meeting principles of sustainable forest management and balancing the needs of different stakeholders.
Key aspects of such an approach include:

- Managing natural capital - developing, restoring and/or managing forests for the full range of ecosystem services they provide from timber to carbon storage, watershed protection, etc.
- Resource efficiency - producing more with less through innovations in technology and through improvements in management and organisation or 'soft' technological innovation.
- Sustainable consumption - harnessing the power of demand and the market to drive improvements.

However, there is some overlap between these three categories, as some demand-driven interventions can reinforce the supply-side measures focused on natural capital and resource efficiency. For example, certification of sustainable forest management can be both natural capital and sustainable consumption as it is aiming to ensure that timber harvesting does not deplete natural capital (and social capital) but is often driven by demands of the market. There are also more indirect interventions and enabling conditions such as good forest governance, and access to finance which are not listed here but are discussed in more general terms in the final chapter.

3.3 Natural capital interventions

The common feature of these interventions is that they are aimed at maintaining, enhancing or restoring forests so that they continue to provide private goods such as timber, woodfuel and NWFPs as well as public goods such as carbon storage, biodiversity and water conservation. They essentially involve improved management of natural forest, or extending the forest area through reforestation, afforestation and agroforestry, or restoring natural forest through enrichment planting and conservation set asides or a combination of these.

3.3.1 Natural forests

Improving forest management: SFM to certification standards

While ITTO surveys have shown only a small increase in the area of sustainably managed forests in Africa (Blaser *et al.,* 2011), in certain parts of the continent there has been significant progress. Considerable attention has been given to improving forest management in public concession areas in Central Africa. By early 2013, concessions with a management plan accounted for 38 per cent of all forests under concession in Central Africa and as much as 72 per cent in **Cameroon** (Bayol *et al.,* 2014). Some companies have gone further and have certified their forest management to FSC standards.

There is some evidence of positive impacts, both environmental and social. In **Cameroon**, according to Cerutti *et al*. (2011), adoption of legal management plans led to decreases in harvesting intensity with a reduction in Annual Allowable Cut (AAC) of an average 11 per cent for the five most harvested and traded species. With FSC certification, the reduction in AAC was even higher at 18 per cent on average. This reduction shows the potential positive impact of certification as it allows better recovery of valuable timber species for the next rotation and reduces the likely damage to the residual stand (*ibid*). The social impacts of FSC certification in **Cameroon**, Congo and Gabon have been examined by Cerutti *et al.* (2014) who conclude that in spite of the uneven playing field and scarce price premiums 'certification has pushed companies toward remarkable social progress'. They highlight evidence of better working and living conditions for workers and their families, and better governed institutions for negotiations between local populations and the logging companies (*ibid*).

The companies concerned have also pointed out some positive and negative effects of certification. Rougier, a company with FSC certified forests in Gabon, and Cameroon, observed in relation to its Gabon operation that the additional requirements of forest certification such as increase of harvesting diameters and the need to avoid harvesting trees located on steep slopes or near rivers had led to a reduction in average timber production per area (Rougier, 2013). Moreover, the costs of meeting the certification standards were substantial, more than €1 million per year, of which 60 per cent was for social initiatives – housing, healthcare, sanitation, education etc. (*ibid*). These increased costs have not been matched by price premiums for FSC-labelled products, but the company has found that certification does help in maintaining its current markets and in accessing new ones. It also stresses the considerable non-economic benefits, particularly the improvement of relations with the local communities and improved working conditions 'The process literally transforms the company's entire culture. (Rougier and Clement, 2012 p.24). Pallisco-CIFM, which has certified most of its operations in **Cameroon**, makes a similar point about the lack of price premiums resulting from certification and the advantages of market access but highlights efficiency improvements and cost reductions resulting from the monitoring and evaluation requirements of certification[20].

Local/community licensing and control

Numerous calls have been made for communities to be given control over forests in recognition of their traditional rights with the argument that this will lead to better management (Elson, 2012). Crucially, this provides the first step in the regularisation of the informal timber/forest sector. **Cameroon** provides an example of such an approach with nearly 400,000 ha of communal forests (and a further 400,000 ha in the process of classification), supplying 5-10 per cent of the national timber markets (Bayol *et al.,* 2014). There are major challenges though as the process of classification is costly and cumbersome, and communities often do not have the capacity to run forestry enterprises themselves

[20] http://d2ouvy59p0dg6k.cloudfront.net/downloads/gftn_october_2013_newsletter_final.pdfPallisco-CIFM passes renewal audits to maintain FSC certification till 2018 p.18

or to negotiate effectively with logging companies to get a fair deal (Angu Angu, 2007).

A similar approach is often proposed for management of forests used for sourcing woodfuel either as part of multi-purpose community forests or as dedicated supply areas. **Kenya** with its charcoal producer associations that can apply for licenses to harvest wood fuel and produce charcoal provides an example of the latter but there have been delays in handing out licences and a lack of awareness among authorities, producers and traders about the new rules (Godfrey Wood and Garside, 2014).

3.3.2 Planted forests and agroforestry

Partnerships between big and small players

There have been numerous initiatives to expand the area of planted forest while aiming for high environmental and social performance. This applies to all four types of forest use, whether through industrial plantations, small-scale plantations, or trees on farm, or through assisted natural regeneration and enrichment planting. The main issues or challenges are to ensure that local communities benefit given that land allocated by governments to investors for plantations often have informal but sometimes formal claims from communities for land and resource access. The main environmental issue is the role of intensively managed exotic species and the perceived trade-off between high yields and adverse impacts on biodiversity and water availability and other ecosystem services. Different models have emerged to address both of these issues but have received both praise and criticism.

In **Mozambique**, the Norwegian company, Green Resources, has followed a corporate social responsibility approach, establishing an FSC certified commercial plantation of exotic species (eucalyptus and pine) for production of sawn timber and utility poles, as well as generation of carbon emission reductions through the CDM with validation by the Climate Community and Biodiversity Alliance standard[21]. Community benefits are through employment, investments made by the company in agricultural programme and a school and allocation of 10 per cent of the carbon revenues to finance local community initiatives. While the certifications achieved indicate the good environmental and social credentials of the plantations there are concerns expressed by some NGOs over the impact of the land acquisition on land rights of local communities and the use of exotic species[22].

In **South Africa**, the company, Mondi, has employed several approaches to ensure local communities benefit, often in combination. For example in Siyaqhubeka forests (SQF), Mondi is in a joint venture with government agencies and two community trusts, one representing communities that surround the

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[21] http://www.greenresources.no/Plantations/Mozambique/Niassa.aspx
[22] http://ejatlas.org/conflict/green-resources-as-niassa-project

plantations, the other local outgrowers, and has paid dividends to these shareholders[23]. But it also supports communities in setting up their own businesses in the tree production and forest value chain, as well as community social investment initiatives[24]. It has not been without criticism though for example that the social investment initiatives benefit the better qualified, locking out the poorer and less-skilled (Ojwang, 2009).

In other areas, Mondi, in response to land claims from communities (who since 1994 have the right to claim back land that they were forced from) is assisting such communities to participate in forestry operations with a view to eventual control after at least ten years once they have built up capacity. The first settlement was in 2009 with the AmaHlongwa and AmaBomvu communities who have benefited from contracting opportunities and support from Mondi for training and capacity building as well as development initiatives[25].

Community-based tree planting[26]

Some initiatives in **Kenya** involving community groups have shown some success in planting trees for charcoal production. In Rarieda District in Siaya County, the Youth to Youth Action Group (YYAG) now part of Rarieda Agro-Forestry Development Initiative Programme (RAFDIP), an umbrella organisation of community self-help groups, teamed up with Thuiya Enterprises Ltd in 2002 to mobilise farmers to plant acacia trees on a six year rotation, and to encourage them to get into charcoal production. YYAG raised the seedlings and gave them on loan at zero interest to the farmers. The loan would be repaid when the wood or charcoal was purchased by Thuiya Enterprises. Farmers were also given groundnuts and beans to intercrop with the acacia trees in the initial two years so that they could get some revenue while the trees were growing. From year 3, they were loaned a beehive for every 500 trees they planted, to be repaid over three years with a portion of the honey produced. Government agencies and universities supported the initiative with provision of seedlings, as well as advice and training on tree growing and efficient production of charcoal.

While this initiative has encountered challenges such as prolonged droughts, and high cost of transport, it is considered successful. The area planted with acacia reached 240 hectares involving 545 farmers with woodlots ranging from 0.21 to 1.25 ha in area. Farmers gained knowledge and skills in tree planting and harvesting, and community based organisations in the area expanded and were strengthened.

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[23] http://www.saforestrymag.co.za/articles/detail/siyaqhubeka_forests_10_years_on
[24] http://www.siyaqhubeka.co.za/page/new-generation-plantation
[25] http://newgenerationplantations.org/multimedia/file/5cc60a72-77cc-11e3-92fa-005056986313/ and http://sd-report.mondigroup.com/2011/performance-against-objectives/sustainable-fibre/case-studies/land-claims-business-development
[26] This section is drawn from PISCES (2012).

3.3.3 REDD+ and multiple benefit streams

A number of African countries are working with the UN REDD Programme and/or the Forest Carbon Partnership Facility (FCPF) to develop national REDD+ strategies and to prepare for implementation[27]. Three African countries, the Democratic Republic of Conga, Republic of Congo and Ghana, are in the pipeline for the FCPF's Carbon Fund which will pilot large-scale programmes of performance-based payments for REDD+ actions. The various readiness activities are beneficial for forest governance in increasing knowledge about forest assets and prompting stakeholder discussions about forests and land use. But while some countries, for example DRC, are moving ahead quite rapidly it will be some time before REDD+ programmes are in full implementation in most countries, and considerable amounts of funds will be needed. In the meantime, there are several voluntary forest carbon projects or CDM projects, in operation in Africa that, even if small relative to the REDD+ programmes being planned, provide an indication of what can be achieved in practice, how local communities can be involved, and the range of benefits that can be generated beyond carbon.

The Sofala Community Carbon project in **Mozambique** started in 2002 and by July 2012 had sold US$ 2 million in carbon credits from 310,000 certificates and paid over US$2 million to 2,800 participants for PES and direct management activities (Plan Vivo Foundation, 2012). The project was certified to the Climate Community and Biodiversity Standard with triple gold status indicating that it has potential to generate a wide range of benefits. Participants receive carbon payments but the major benefits for them will come from the sustainable land use activities that the project is enabling them to implement (*ibid*). This project has had to rely heavily on donor funding and has faced challenges in securing sufficient carbon buyers to keep pace with the signing of agreements with farmers. At present there is a waiting list of farmers who want to join the scheme (ESL, 2014).

The Humbo Community-based Natural Regeneration project in **Ethiopia,** which started in 2005, is registered with the CDM to receive carbon credits for restoring 2,728 hectares of degraded forests with indigenous species through farmer-managed natural regeneration. Carbon revenue has been received from the World Bank's BioCarbon Fund but the direct livelihood benefits are arguably more important. Farmers received non-carbon benefits at a very early stage in the project, being able to harvest fodder and firewood within a year and wild fruits and other NWFPs within three years (Brown *et al.*, 2011). They also benefited from the establishment of cooperatives with secure legal title to the forest (*ibid*).

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[27] 18 African countries including all our case study countries except South Africa, are REDD+ countries in the FCPF's Readiness fund. (https://www.forestcarbonpartnership.org) The UNREDD programme has 24 partner countries in Africa including all our case study countries except Mozambique and South Africa. http://www.un-redd.org.

3.4 Resource efficiency interventions

Opportunities exist for improving efficiency in the production of goods or services derived from timber, woodfuel and NWFPs for both large scale and small-scale or community-based operations. Landscape approaches to land use planning in forest mosaics can optimise the provision of ecosystem services. There are also more indirect opportunities: to increase efficiency in economic productive activities such as agriculture that drive deforestation to reduce the pressure on forests. This is particularly relevant to REDD+ activities.

3.4.1 Improved productivity of planted forests and agroforestry

There are opportunities to increase the productivity of planted forests as well as in improving the efficiency of harvesting and processing. The potential of the former can be demonstrated by production trends in **South Africa** where in spite of declining area dedicated to forest plantations, average productivity increased by more than 40 per cent over the period 1980 to 2012, increasing from $10m^3$/ha to $14.5m^3$/ha by the end of this period and reaching nearly $18m^3$/ha in some of the intervening years (Godsmark, 2014). Sand and Lewis (2012) argue that many countries in Africa have the potential to exceed MAI of $20m^3$/ha in Forest plantations and that the economic multiplier effect could be as high as 20:1.

At the other end of the scale spectrum, the Tree Biotechnology Programme, promoted eucalyptus hybrids based on clonal forest technology to smallholders in East Africa and distributed 21 million trees to 20,000 growers across the region for about 10 years from the late 1990s (Kilimo Trust, 2011). The aim was to demonstrate that such clones could grow well in East Africa if planted on the appropriate sites. It acknowledged the concerns about water use and impact on wildlife habitats but argued that these issues arise primarily because of inappropriate species choice. With clonal planting materials matched to agro-climatic conditions, eucalyptus can provide wood for construction and energy within 6 to 10 years while not using more water than indigenous trees (*ibid*). However, the future success of this approach to planting trees will depend on a strong tree research and breeding programme to ensure that the genetic base remains sufficiently broad as well as a well-structured tree value chain with market information and finance accessible to tree growers (*ibid*). In **Kenya**, a public-private trust was set up in 2007 to continue the work of the programme and produces over 5 million tree seedlings annually for various ecozones in spite of challenges such as adverse negative publicity on eucalyptus, escalating costs of inputs and inadequate funds for further research and development in hybrid clones and species selection [28].

3.4.2 Wood processing technology

Wood processing conversion efficiency in the forest sector in Africa is typically very low although there is considerable variation. Whereas sawmills operate at around 50 per cent efficiency in developed countries, with some mills in Europe and North America achieving 70 per cent (WWF, 2012), efficiencies of 34 per cent

[28] http://www.tree-biotech.com/ viewed on 13 June 2015

have been observed in **Ghana** (Mayers *et al.*, 2008) and less than 40 per cent in Nigeria (Blaser *et al.*, 2011). In the latter case, the low efficiency is due to the use of machines designed for large diameter logs rather than the smaller diameter ones that are now the main type available (*ibid*). But there are other opportunities for improving efficiency that do not require the replacement of machinery. An ITTO training workshop in several tropical countries, including **Cameroon** and **Ghana**, found a general problem of losses of volume and deterioration of quality related to the handling and storage of materials. It proposed simple solutions such as using basic equipment like sheets for covering the products, and training staff in how to stack materials and products (ITTO, 2014).

York Timbers, an FSC certified plantation company in **South Africa**, provides some indication of the potential for increasing processing efficiency. At one of its sites it has increased fibre utilisation by installing materials handling equipment specifically designed for short logs; and at one of its sawmills, it has installed a finger joint machine at one of its sawmills to increase utilisation of offcuts (York Timbers, 2014). It has set a goal to go from a situation where 90 per cent of turnover is derived from 40 per cent of the tree, and by implication where 60 per cent of the tree generates only 10 per cent of turnover to one where 60 per cent of the tree generates 90 per cent of the revenues. It plans to achieve this through new wood processing and energy generation equipment, new product lines to make use of residues, and an integrated site (York Timbers, 2013).

3.4.3 Supply chain organisation

Opportunities for efficiency improvement are not confined to large-scale companies in the formal sector and in small-scale operations and in the informal sector there is scope for productivity gains through cooperation in the purchasing of equipment for example. In **Cameroon**, Tropenbos is setting up wood clusters to concentrate actors of the domestic wood value chain in the same place. These aim to demonstrate the possibility of supplying the local market with legal lumber but will also promote increased efficiency as individuals involved in chainsaw logging will be able to join forces to buy tools and equipment (Tropenbos, 2012).

Similar considerations apply to NWFPs. There is scope to increase efficiency in the use of the raw materials and also to improve the quality of the final product. In **Ghana**, a new initiative is training groups of rattan artisan furniture producers so that they can improve quality and efficiency and so generate higher income[29]. The Savannah Fruits Company in **Ghana** is sourcing organic certified shea nuts from 1,500 rural women and contracting 2,000 women to manually process the nuts into butter using traditional techniques while remaining in their villages. This enables greater value addition at source and greater returns to the women producers than if they were selling the nuts. Industrial processing can get a higher recovery rate of shea butter from the shea nuts than traditional manual methods. However, the company markets the shea butter as traditional handcrafted, implying superior quality for certain types of buyer[30].

[29] http://www.inbar.int/2014/08/rattan-industry-gets-support-in-ghana/
[30] http://www.savannahfruits.com/sustainability.html

3.4.4 Improved charcoal kilns

Traditional charcoal production methods, typically an earth mound or a pit kiln, have efficiencies of 10-15 per cent which means that it takes about 6-10 tonnes of sun-dried wood to produce 1 tonne of charcoal. Greenhouse gas emissions of the traditional methods are very high because the tar fraction is not recovered and gases such as methane (CH_4) with high global warming potential are emitted to the atmosphere. However, an experienced producer can achieve 20-25 per cent efficiency with these traditional methods, and improved versions of these methods such as the Casamance earth-mound have similar efficiencies (FAO, 2010b). Alternative technologies such as the metal kiln or brick kiln can achieve 25-33 per cent but still with high greenhouse gas emissions, while the Adam retort kiln has an efficiency of 35 per cent as well as relatively low greenhouse gas emissions, (Maes and Verbist, 2012).

Despite efforts to promote these technologies dating back to the 1980s (e.g. FAO 1983; Foley 1986 (cited in Maes and Verbist, 2012)) there has been very little uptake because of high upfront costs, and because of the negative view of charcoal production on the part of many developing country governments which forces it to remain in the illegal and at best informal economy. The growing concern about climate change and GHG emissions and the momentum behind green economy has led a change in perspective in recent years. **Ghana**'s Strategic National Energy Plan 2006-2020 set targets to increase the efficiency of charcoal production, reducing the wood intensity from 4:1 to 3:1 in the savannah zone and from 5-6:1 to 4:1 in the rainforest zone (UNDP, 2014). The Ghana NAMA study estimated that if these targets could be achieved by 2015, there would be a reduction in annual wood input for charcoal of 38.5 per cent from the input projected in BaU (UNDP, 2014).

3.4.5 Improved stoves

Improvements in cookstove technology have been promoted since the 1970s but with limited success until recently, in spite of advantages beyond reduced fuelwood requirements of reduced indoor air pollution and greenhouse gas emissions. The main reason for the failure of these early programmes was the lack of attention given to users' needs and preferences (Maes and Verbist, 2012). The introduction of the CDM and the voluntary carbon market contributed to a resurgence of interest in improved stoves given the possibility that carbon finance could help to reduce the costs for stove users. By 2007, 8 million improved stoves were in use in Africa (Maes and Verbist, 2012) and by 2009, the region's first CDM improved stoves project had been approved in Nigeria (Blunck *et al.,* 2011). NGOs and carbon offset retailers have played an important role in promoting improved stoves in recent years. INBAR has facilitated the use of nearly 450,000 improved stoves in **Ethiopia** and **Ghana**[31], while World Vision has a Gold Standard CDM project in Oromiya in **Ethiopia** which is aiming to introduce 80,000 stoves in its main phase (Bass *et al.,* 2013)[32].

[31] http://www.inbar.int/2013/09/inbar-makes-strides-in-highly-renewable-energy-in-africa/
[32] http://wvfoodandclimate.com/home/regions/africa/ethiopia-2/#.U8UOjJRdUUk

Some larger scale initiatives are now being developed. The Africa Clean Cooking Energy Solutions Initiative was established in 2012 by the World Bank to promote enterprise-based large-scale dissemination and adoption of clean cooking solutions (World Bank, 2012). It will work in partnership with the Global Alliance for Clean Cookstoves and Sustainable Energy For All. A number of countries have set targets for the introduction and uptake of improved stoves with varying degrees of ambitions. **Ghana**'s National Energy Plan 2006-20 sets fairly modest targets to achieve 5 per cent uptake of improved cookstoves by 2015 and 10 per cent by 2020 (UNDP, 2014). **Ethiopia**'s Biomass Energy Strategy and Action Plan (2014) and its CRGE has an ambitious objective that by 2030, 80 per cent of rural and 5 per cent of urban households will use fuelwood efficient stoves and mitads. With 5 per cent of rural and 61 per cent of urban households switching from fuelwood to electric stove use by 2030.

Impacts

The effects of improved stoves on biomass requirements as well as air pollution and greenhouse gas emissions depend on the technical design, and on context-specific factors such as the source of wood biomass used for cooking and charcoal conversion and the extent to which it is renewable, and how people respond in terms of uptake and the amount of cooking they do. As a result there is considerable variation. Maes and Verbist (2012) cite a range of 10 to 50 per cent reduction of biomass consumption. World Vision's Energy Efficient Stoves CDM project in **Ethiopia** involves the distribution of 30,000 energy efficient cooking stoves which it claims will use up to 60 per cent less wood than conventional open fires[33]. The energy-efficient cook stove project in Kakamega, **Kenya** is employing a natural ceramic stove that is claimed to be 35-50 per cent more efficient than the traditional three stone stove[34].

Implications for carbon emissions **-** If the wood biomass that is normally used for cooking and charcoal production comes mostly from a non-renewable source, that is, extraction is at rates that exceed natural regeneration capacity or the growth rate of planted forests and trees outside forests, then most of the gross CO_2 emissions can be considered as net emissions. But if woodfuel is being sourced from forests where the extraction rate is sufficiently low to allow regrowth, or from trees outside forests or dedicated woodlot plantations, then net emissions from using woodfuel would be close to zero. As discussed in the previous chapter, there are different views about this and a lack of firm data at the regional level[35].

[33] https://cdm.unfccc.int/filestorage/p/z/G8Q2UT1ECRPBZX3O6IJSHFMWKL9V75.pdf/WVApercent20F-CDMSSCCPADD.pdf?t=U1R8bmYxazY1fDASw_rKPDm8xtFMazW74kqR

[34] http://www.myclimate.org/carbon-offset-projects/projekt/energy-efficient-cook-stove-in-kakamega-kenya-120/

[35] CDM default values of the fraction of non-renewable biomass are mostly above 70per cent for African countries but rely on an assumption that all biomass removals outside protected areas are non-renewable so that biomass growth will occur only in protected area forests (UNFCCC Information note (Ref: EB 67, Report; Annex 22). This is

Other greenhouse gases - Reductions in emissions of other greenhouse gases also need to be considered, particularly methane (CH_4). These are particularly high in charcoal production, including with the improved technologies except for the Adam-Retort[36] as this is able to combust 75 per cent of the methane fraction (Maes and Verbist, 2012). Bailis *et al.* (2004) in a study of wood fuel use in Sub-Saharan Africa estimated that each meal cooked with charcoal had 2-10 times the global warming effect of cooking the same meal with firewood and 5-16 times the effect of cooking with kerosene or LPG. The range reflected the gases included in the analysis and the degree to which the woodfuel was from renewable sources.

Indoor air pollution and health impacts - While there is uncertainty about the extent of impacts on CO_2 emissions as well as other GHG emissions of these two interventions, there is a substantial body of evidence on their potential in reducing indoor air pollution and related health effects. World Bank (2012) estimates that exposure to indoor air pollution from incomplete combustion of biomass fuel accounts for nearly 500,000 premature deaths per year in SSA. Evaluations of improved stoves in African countries have shown that they can reduce indoor air pollution significantly. In **Ghana**, wood-burning improved stoves have been shown to reduce average 24 hour particulate matter (PM 2.5) concentrations by 52 per cent (AFREA, 2011).

Other development and local economy impacts/benefits - There is considerable potential to generate new types of job and enterprise for the manufacture and distribution of improved cookstoves and the construction of charcoal retort systems. In **Ghana**, for example, Toyola Energy Limited involved 172 people in the production and assembly of 52,000 stoves with further income generated in the supply chain as traders and agents earned about 10 per cent of the retail price on each sale (Ashden Awards, 2011). In **Kenya**, producers of improved cookstoves earned an average income of US$120-US$240 (Afrea, 2011 citing GTZ, 2009).

Where households have to buy fuelwood or charcoal the potential savings can make a difference, with estimates that that households owning one of the latest types of improved stoves can save half a tonne of fuelwood per year freeing up income for other expenditure (Afrea, 2011 citing Adkins *et al.,* 2010). Where fuelwood is collected for subsistence use, the time savings can be important, allowing women and girls time for education and income generation (World Bank, 2012). Time savings in cooking from the use of improved stoves can also be appreciated. Women cooking with improved stoves in Kenya, used the time

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questionable as it takes no account of sources of fuelwood outside of forests or the capacity of harvested woodfuel species to regenerate (See also Lee at al 2013).

[36] The Adam-Retort is a new technology for charcoal production in which charcoal is produced in a closed container with smoke and gases leaving through one opening (Maes and Verbist, 2012)

gained for farming, income-generating activities, girls' education and participation in community life (Afrea, 2011 citing GTZ, 2009).

3.4.6 Forest-saving' agricultural and landscape management

A number of REDD+ projects are explicitly incorporating actions to increase agricultural productivity, to reduce the pressure on forests. It is increasingly recognised that efforts to reduce carbon emissions need to build on the productive activities of farmers and not close them off altogether. In **Ghana**, REDD+ projects/programmes are being developed in cocoa landscapes with activities aimed at doubling the yield of cocoa per hectare and hence slowing down the expansion into forest. While increasing yields could have unintended consequences in increasing the returns from clearing forests, the programme put forward to the FCPF's Carbon Fund proposes to reduce this risk through a large-scale integrated approach involving land use planning and extensive cross-sectoral collaboration, notably bringing the Cocoa Board and the Forestry Commission to work together for the first time (FCPF, 2014).

3.5 Sustainable consumption interventions

3.5.1 Overview

International multi-stakeholder initiatives and regulatory change in developed country markets are providing the momentum for sustainability improvements, particularly for timber through demand for legal or certified timber and ecosystem services through REDD+. A recent development is the forging of public-private partnerships involving multinational food companies with the aim of reducing deforestation in supply chains of agricultural products. This is recognition that efforts by national governments to improve forest management can be undermined by large international demand for agricultural and particular forest product commodities. But as exports are often dwarfed by domestic consumption of forest products and agricultural products, national level demand-side measures are needed as well and can potentially have a wider scope of influence. There is some indication though that international demand side measures can stimulate the introduction of national level demand side measures.

3.5.2 Certification of forest products

Efforts to promote certification of forest products to FSC and other international scheme standards, combined with supportive networks and partnerships, such as the Global Forest and Trade Network led by WWF have driven improvements in export-oriented forest operations. In **Cameroon**, four major forest product companies with a combined forest managed area over one million ha are participants in this network[37] while a fifth company, Rougier, has recently joined as part of a strategic collaboration with WWF France[38].

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[37] http://gftn.panda.org/about_gftn/current_participants/gftn_members.cfm?country=Cameroon&countryid=2

[38] http://gftn.panda.org/newsroom/gftn_news/?245210/WWF-France-and-Rougier-to-jointly-advance-responsible-forest-management-and-trade

3.5.3 Legislation and procedures to prohibit the import of illegal timber

Reinforcing these voluntary efforts, a major demand-side driver has been the move in developed countries to introduce legislation to prohibit the import of illegal timber. Examples include the Lacey Act in the US and the European Union Timber Regulation (EUTR) which entered into force in early 2013. The EUTR prohibits operators in Europe from placing illegally harvested timber or products derived from this on the EU market[39]. The means of implementation is through voluntary partnership agreements (VPAs) between timber exporting countries and the EU. Under these agreements the timber-producing country agrees to set up and operate a licensing system for the legality of its timber exports, underpinned by a legality assurance system, and the EU agrees to accept only licensed imports from that country (*ibid*). By the end of 2013, five African countries (**Cameroon**, Central African Republic, **Ghana**, Liberia and Republic of Congo) had signed VPAs, and a further three countries (Côte d'Ivoire, DRC and Gabon) were in the process of negotiation (FAO, 2014b). However, there were as yet no FLEGT licences issued as the process of implementation has proved more complicated than anticipated (*ibid*).

While the VPA process has been lengthy and complicated, there have been significant benefits in terms of forest governance because of the inclusion of local stakeholders including civil society and the private sector (FAO, 2014b). In the absence of country licensing systems, voluntary certification schemes for legality or for compliance with FSC certification standards are playing an important role in enabling exporters to provide the guarantees that importers are now obliged to seek (Bayol *et al.,* 2014).

The impact of the EUTR on the domestic market is likely to be limited but several African countries, including **Cameroon** and **Ghana**, are incorporating the domestic market into their VPAs. This presents major challenges to address problems such as lack of local ownership and control of forest resources and partly explains why there have been delays with VPA implementation (FAO, 2014b). On the other hand it has prompted introduction of policy innovations focused on the domestic market. **Ghana**, for example, has adopted a new policy for the domestic market which includes the development of a legal value chain for artisanally produced timber and measures to ensure supply of legal timber to public markets (FAO, 2014b). It has also proceeded with preparation of a public procurement policy on timber and timber products to send a market signal in favour of legally and sustainable produced timber and wood products (NDF, 2015).

[39] http://www.euflegt.efi.int/documents/10180/37877/Guidance_EUTR_and_VPA_13April.pdf/95e2dc37-48c0-49c1-b1c3-6e23bc5b8193

3.5.4 Organic and fair trade labelling of 'natural' food and health products

As with timber, the main demand drivers for sustainable NWFPs have come from the export market. There is a growing market for natural products in developed countries. For example, the North American natural cosmetics market is over US$5 billion while the market in functional foods or 'superfoods' a key product use for natural products was expected to reach US$ 8.61 billion in 2015 ITC (2012b). Moreover, according to ITC (2012b), in the North American market for natural products it is no longer sufficient to be a supplier of a desirable product. It has to score highly on safety, sustainability and eco-social demands. This provides an important market incentive for NWFP initiatives that seek to address the sustainability of harvesting and to ensure that primary collectors get a fair deal.

Certification is an important market tool, particularly when combined with a supply chain network and is delivering positive results in different regions. In West Africa, the Global Shea Alliance, established in 2011 and based in **Ghana,** is a non-profit industry association encompassing women's groups, small businesses, suppliers, international food and cosmetic brands, retailers and non-profit organisations, which aims to drive a competitive and sustainable shea industry while improving the lives of rural African women and their communities [40]. Certification of shea kernels and shea butter has become important to meet requirements for traceability and demand from cosmetic companies for organically certified shea butter[41].

In Southern Africa, Phytotrade Africa, a natural products trade association has 60 members in nine countries (including **Mozambique** and **South Africa**) and seeks to combine both organic and fair trade standards for wild harvested products. Its objective is to deliver large volumes of sustainably harvested high quality natural products with a focus on cosmetics, food and beverages and herbal supplements. Baobab is one of the products it is currently promoting. In 2008, it managed to overcome a regulatory hurdle to the expansion of the export market for this product by securing an EU Novel Foods decision. This allowed the supply of baobab fruit to the European food and drink market[42]. Ecoproducts, one of its trading members, based in Limpopo Province, **South Africa** and selling certified organic baobab oil and baobab powder to the manufacturing and retail sectors, is working with 1,000 women who receive income from harvesting baobab fruit[43]. Another member, Bio-Óleos de Miombo (BOM) in **Mozambique**, which is also a member of the Union for Ethical BioTrade, is working with rural communities to sustainably harvest local oilseeds, for manufacture and marketing of organic skin and body care products[44]. While each initiative may seem small in terms of

[40] http://www.globalshea.com/about/15/Mission-Vision
[41] http://www.globalshea.com/work/14/Industry-overview
[42] http://phytotrade.com/about-us/
[43] http://www.ecoproducts.co.za/about-us
[44] http://biooleos.com/

product volume, Phytotrade estimates that the amount received by the collectors of these natural products sums to millions of dollars.

3.5.5 Appropriate technology

Some initiatives are beginning to focus on domestic markets. In **Ghana** there are some promising initiatives to promote non-wood forest products such as bamboo as sustainable alternatives to wood products in housing construction, (this is important because Ghana is faced with the need to import timber)[45]. It also has a project that shows the versatility of bamboo in providing a strong, lightweight, alternative to metal in the manufacture of bicycles. The bamboo bikes initiative focuses on domestic and international (EU & US) markets and aims to provide opportunities for women and young people. So far it has created 30 jobs (20 bike assemblers and 10 farmers[46]).

3.5.6 Corporate commitments, partnerships and disclosure

Zero deforestation commitments are being made by multinational companies buying wood and fibre products or agricultural products that are often associated with forest clearing. So far most of the activity has been in Asia and Latin America. However, the Tropical Forest Alliance 2020 in collaboration with the Consumer Goods Forum has a pilot project on oil palm development in Africa. This aims to develop a framework that takes account of African countries' development plans while addressing environmental targets for reduced deforestation, land use and greenhouse gases as well as social indicators such as land tenure and the rights of indigenous peoples (TFA, 2014).

Linked with these demand driven initiatives is the increasing pressure on companies producing forest products, or products with potential impact on forests, to disclose their carbon emissions. Such information is important for shareholders as an indicator of climate-related risks facing the company. Mondi and Sappi, two major paper and forest products companies in **South Africa**, report information to the country on the Carbon Disclosure Project (CDP)[47]. A recent study by the UCLA School of Management based on three years of corporate CDP data as well as interviews with 40 companies has highlighted the benefits to businesses of participating. While investor demand is the main reason why companies decide to participate in this initiative, nearly half those interviewed found benefits from being able to identify opportunities and manage risks[48].

3.6 Green economy scenario analysis

The preceding sections reviewed a wide range of interventions that could make a difference to the green economy contribution of forests. In this section we examine the implications of some of these interventions focusing on timber and woodfuel. We make projections of the likely impact of these interventions on

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45 http://www.ghana.gov.gh/index.php/2012-02-08-08-32-47/features/5688-ghana-promoting-bamboo-production-and-usage-in-our-housing-industry
46 http://unfccc.int/secretariat/momentum_for_change/items/7842.php
47 https://www.cdp.net/CDPResults/CDP-south-africa-climate-change-report-2014.pdf
48 http://blog.cdp.net/the-growing-business-case-for-disclosure/

timber supply and woodfuel demand at the regional level and consider the knock-on consequences for the economic contribution of the forest sector and for carbon emissions. Owing to data limitations and the importance of local variation it is not possible to make regional level projections for all of the interventions discussed in this chapter.

3.6.1 Timber

Impact of sustainable management of natural forests on timber supply

In the previous chapter (Table 5) it was estimated that harvesting intensity in 2030 and 2050 would need to be considerably higher than a sustained yield level for supply to be sufficient to meet demand. (This assumes that there will still be such amounts available in the remaining PFE). If we assume that harvesting intensity compatible with sustainable forest management standards with certification is 0.375 m^3/ha /year (derived from the midpoint of the range of 0.25-0.5 suggested by Alder, 1999) the amount of timber that can be produced from the area of designated PFE less areas of predicted deforestation but plus projected plantation expansion under BaU will be considerably lower than projected demand (Table 8). The shortfall in 2030 would range between roughly 50 million m^3 and 80 million m^3 per year and by 2050 would be more than half of projected demand under both BaU scenarios.

To address this shortfall, the most likely response would be to maintain or intensify the current dependence on timber imports (except where it is possible to designate further areas of forest as PFE as in the DRC). This would not be beneficial though to the economy of the country concerned and would lead to a reduction in employment and value added for the sector. It is important therefore to consider the effect of accompanying interventions such as reducing deforestation, expanding the area and productivity of planted forest, as well as agroforestry and increasing processing efficiency.

Table 8 Impact of reduced harvesting intensity on timber supply

Demand and supply variables	2030		2050	
	Low demand high supply	High demand low supply	Low demand high supply	High demand low supply
Cumulative forest loss from base year mn ha E	64.3	111.6	122.0	204.0
Cumulative forest loss in natural forest production PFE mn ha F	21.1	36.5	39.9	66.8
Natural forest production PFE after deforestation mn ha G (D-F)	172.4	157.0	153.6	126.7
Industrial roundwood supply potential				
Natural forest production PFE mn m3/yr @0.375 H	64.7	58.9	57.6	47.5
Planted forest mn m3/year J	32.8	30.5	38.7	33.1
Total supply potential mn m3/year K (H+J)	97.5	89.3	96.3	80.6
Industrial roundwood demand (mn m3/year) L	146.6	171.1	206.0	304.4
Surplus or (shortfall) mn m3/year M (K-L)	-49.1	-81.8	-109.7	-223.8

Impact of resource efficiency interventions on timber demand supply balance

The impact of efficiency/productivity improvements in both planted forest and wood processing on the future supply/demand balance is examined in Table 9. This takes the supply from natural forest production PFE with the reduced harvesting intensity associated with SFM/certification and adds production from planted forest, assumed to increase at a much higher rate than under BaU. The high supply scenario for planted forests is based on assumptions in GEF (2012) of land expansion of 1 per cent per year and 2 per cent per year productivity improvement. This would give a production from planted forests in 2050 of 87 million m^3, just over three times the estimated current level of production. This accords with the WBCSD vision of tripling planted forest production worldwide by 2050 (WBCSD, 2012). The low supply scenario is based on the rate of expansion (1.75 per cent per year) in area of planted forests of all types from 2000 to 2010 based on figures in FAO (2010a) assumed to continue up to 2030 and 2050.

Table 9 Effect of productivity improvement in planted forests and increase in processing efficiency

Industrial roundwood demand supply and demand variables	2030		2050	
	Low demand high supply	High demand low supply	Low demand high supply	High demand low supply
Natural forest production PFE mn m3/yr H	64.7	58.9	57.6	47.5
Planted forest mn m3/year J	48.1	38.61	86.88	54.62
Total supply potential mn m3/year K (H+J)	112.8	97.5	144.5	102.1
Supply equivalent with incr processing efficiency*	161.26	128.67	206.59	134.83
Industrial roundwood demand (mn m3/year) L	146.6	171.1	206.0	304.4
Surplus or (shortfall) mn m3/year (K-L)	14.7	-42.5	0.6	-169.6
* 32% increase in the conversion rate in low supply and 43% increase for high supply				

Increases in processing efficiency in Table 9 are based on a study in Ghana (Mayers *et al.,* 2008) which considered that the conversion rate could increase from 34 per cent to 45 per cent. This equates to a 32 per cent increase in supply and this is used for the low supply scenario. An example from Paragominas in Brazil suggests that a combination of improved log storage, upgraded sawmilling equipment and new product lines to make use of small pieces of wood could improve conversion efficiencies from 35 per cent to 50 per cent for sawmills (and from 39 per cent to 60 per cent for veneer mills)(Gerwing *et al.*, 1996). These more extensive improvements observed in Brazil equate to a 43 per cent increase in supply and this is used here for the high supply scenario. Even though this figure does not come from Africa, it gives an indication of further potential that can be achieved.

The combined effect of these two green economy interventions is to reduce the shortfall in supply considerably and to eliminate it altogether in the case of the lower demand estimate under BaU (low demand scenario).

Reducing deforestation through agricultural efficiency improvement

So far the projections made have assumed no reduction in deforestation from BaU. As many REDD+ projects and agricultural supply chain initiatives are attempting to tackle deforestation by addressing agricultural productivity it seems reasonable to assume that some reductions can be achieved.

FAO's study of food production needs by 2050 (Alexandratos and Bruinsma, 2012) shows the potential contribution of increasing agricultural productivity in tackling deforestation and the potential size of the reductions. Although food demands are estimated to require a tripling in agricultural production by 2050, the study estimates that this could be achieved with a 51 million ha increase in land under rainfed crops in SSA, provided there was a significant increase in agricultural productivity. This would be about 45 per cent of the expected deforestation based on historical trends. It is projected that 74 per cent of the increase in agricultural production would have to come from yield increases, 6 per cent from increases in cropping intensity and 20 per cent from land expansion. This is somewhat different from the pattern in the period 1961-2007 when the shares of the three sources were much closer together 38 per cent for yield increase, and 31 per cent each for the two other sources.

A key issue is the potential for agricultural yield increase in Africa. The global average crop yield growth rate is declining but in SSA which has seen very little growth in yields over the last 20-30 years, Alexandratos and Bruinsma (2012) predict that yields will grow at a rate higher than the historical trend. It is shown that there are sizeable gaps worldwide between countries in crop yields and on the basis of experience there is reason to believe that a good part of this gap is exploitable that it is due to differences in crop management practices rather than agro-ecological conditions. Given these projections, it seems plausible that a combination of measures aimed at reducing the pressure on forests could achieve a 50 per cent reduction in deforestation. Table 10 shows the implications for the timber demand and supply balance. The effect is to reduce still further the expected shortfall.

Table 10 Impact of reduced deforestation on timber supply and demand balance

Industrial roundwood demand supply and demand variables	2030		2050	
	Low demand high supply	High demand low supply	Low demand high supply	High demand low supply
Cumulative forest loss from base year mn ha E	32.2	55.8	61.0	102.0
Cumulative forest loss in natural forest production PFE mn ha	10.5	18.3	20.0	33.4
Natural forest production PFE after deforestation mn ha	183.0	175.2	173.5	160.1
Natural forest production PFE after deforestation mn m3 @0.375/ha	68.6	65.7	65.1	60.0
Planted forest mn m3/year J	48.1	38.61	86.88	54.62
Total supply potential mn m3/year K (H+J)	116.7	104.3	152.0	114.7
Supply equivalent with incr processing efficiency*	166.90	137.71	217.30	151.36
Industrial roundwood demand (mn m3/year) L	146.6	171.1	206.0	304.4
Surplus or (shortfall) mn m3/year (K-L)	20.3	-33.4	11.3	-153.1

* 32% increase in the conversion rate in low supply and 43% increase for high supply

3.6.2 Impacts

Jobs and economic contribution of the timber sector

The combined effect of these interventions makes it possible for the sector to continue on a sustainable basis with an industrial roundwood supply from the production PFE that is close to expected domestic demand in both scenarios in

2030 and in one of the scenarios in 2050. This means that the economic contribution of the formal forest sector can still grow in absolute terms as demand increases without the raw materials supply constraints expected under BaU. However, this may not be sufficient to stem the decline in the relative economic contribution of the forest sector in comparison to other sectors. Moreover, the increases in processing efficiency could actually exert downward pressure on the number of workers required by the sector, although having positive effects on labour productivity and the level of skills involved. What is needed as well is a step change in the degree of value added processing. A study of the wood sector in Gabon (Kaplinsky *et al.*, 2010) showed that employment is more than doubled if logs are converted into sawnwood, trebled with production of veneer and quadrupled with production of plywood.

Carbon emissions

SFM in natural forests will lead to lower carbon emissions because of lower harvesting intensities and reduction in collateral damage to other species. An increase in the rate of forest planting will lead to greater carbon removals. However, these impacts will be dwarfed by the effects of reducing the rate of annual deforestation by 50 per cent. This will cut annual emissions by 143 to 236 TgC /year in both 2030 and 2050.

Biodiversity

In the previous chapter it was suggested that a critical logging intensity for biodiversity would be 10 m^3/ha (Burivalova *et al*., 2014). This would equate to 0.3 to 0.4 m^3/ha/year for rotations of 25 to 30 years. The harvesting intensity in natural forests (0.375 m^3/ha/year) that underlies our projections is within this critical range for biodiversity. Our projections therefore show that in theory industrial roundwood supply could be close to the level of expected domestic demand in Africa in 2030 without going beyond this critical harvesting intensity. In 2050, this would also be possible for one of the scenarios but not in the high demand and low supply scenario as this assumes such a high rate of deforestation.

3.6.3 Woodfuel – resource efficiency interventions

To make estimates of the impact of introducing improved technologies we adopt a conservative approach, examining the implications of moving from an average efficiency of 23 per cent[49].on a tonne of wood to tonne of charcoal basis to 30 per cent in 2030 and 35 per cent in 2050. This would imply a 23 per cent reduction in wood input for charcoal from the BaU case in 2030 and a 34 per cent reduction in 2050. The introduction of improved charcoal production technologies would reduce the total amount of woodfuel required in 2030 by about 6-7 per cent and in 2050 by about 11-12 per cent. This is not a major improvement by itself but when combined with programmes to introduce improved stoves which can affect

[49] FAO 2012b indicates 167 kg of charcoal per m3 of wood (5.988 m^3 of wood per tonne of charcoal) and 725 kg of woodfuel per m3 or 1.38 m^3 per tonne. This equates to 4.34 tonnes of woodfuel required to produce 1 tonne of charcoal and an efficiency of 23 per cent.

both the amount of fuelwood and charcoal needed, the impact on wood requirements could be substantial.

Ethiopia's CRGE strategy assumes a saving of 50 per cent for fuelwood efficient stoves (FDRE 2011) but this at the top of the 10 per cent range cited by Maes and Verbist (2012) and therefore seems to be rather optimistic. For our green economy scenario projections we make the more conservative assumption that the reduction in wood consumption from the adoption of improved stoves will be nearer the middle of this range at 35 per cent. This takes into account differences in the way the stoves are used, and the possibility of a rebound effect in that households may react to increased efficiency in stove use by doing more cooking. It also allows for the possibility that the stoves may be used in combination with traditional open fire methods, rather than replacing them completely (Adkins *et al.,* 2010).

For uptake rates we make assumptions that lie somewhere between Ghana's modest rates and Ethiopia's ambitious rates. We further assume that uptake amongst woodfuel users in urban areas will proceed more rapidly than in rural areas because of the concentration of users. By 2030, we assume that the rate of adoption would be 50 per cent of urban users of charcoal and fuelwood and 30 per cent of rural users and by 2050, 80 per cent of urban users and 50 per cent of rural users. We present below the implications for wood requirements in this intervention scenario (Table 11). It can be seen that the effect of introducing improved stoves with the efficiency and uptake assumptions outlined above is to more than halve the compounded annual rate of growth of wood consumption for wood-based cooking. Wood consumption with the improved stoves intervention is 20 per cent lower than BaU in 2050 and over 30 per cent lower if combined with improved charcoal conversion technology.

Table 11 Effect of improved stoves on wood biomass requirements

Wood volume required for cooking	**BaU**	**Green Economy scenario**	
		Improved stoves	**Improved stoves and improved charcoal**
2030			
Fuelwood urban (mn m^3)	117-157	97-129	97-129
Fuelwood rural (mn m^3)	458-523	410-468	410-468
Charcoal urban (mn m^3)	186-247	153-203	118-156
Charcoal rural (mn m^3)	50-57	45-51	34-39
Total woodfuel	812-983	705-852	659-792

CAGR 2011-2030	1.27 per cent-2.29 per cent	0.52 per cent-1.52 per cent	0.16 per cent-1.14 per cent
Share of urban woodfuel (per cent)	37 per cent-41 per cent	35 per cent-39 per cent	33 per cent-36 per cent
Share of urban woodfuel and rural charcoal (per cent)	44 per cent-47 per cent	42 per cent-45 per cent	38 per cent-41 per cent
2050			
Fuelwood urban (mn m^3	168-270	121-194	121-194
Fuelwood rural (mn m^3)	557-644	459-531	459-531
Charcoal urban (mn m^3)	266-424	191-306	126-201
Charcoal rural (mn m^3)	61-70	50-58	33-38
Total woodfuel	1,051-1,408	821-1,087	739-964
CAGR 2011-2050	1.28 per cent-2.05 per cent	0.64 per cent-1.37 per cent	0.37 per cent-1.06 per cent
Share of urban woodfuel (per cent)	41 per cent-49 per cent	38 per cent-46 per cent	33 per cent-41 per cent
Share of urban woodfuel and rural charcoal (per cent)	47 per cent-54 per cent	44 per cent-51 per cent	38 per cent-45 per cent

Implications for greenhouse gas emissions

A challenge for the estimation of net CO_2 emissions from the upscaling of improved cookstove programmes and improved charcoal production is determining how much of the wood biomass that is normally used for cooking comes from a well-managed source. Reductions of gross emissions can be estimated by applying the default value CO_2 emission factor of 1.747/tonne of firewood (derived by Gold Standard 2013 from IPCC 2006)[50]. This equates to 1.266 t CO_2/m^3 of wood[51]. This gives gross CO_2 emission reductions of 395 to 562 million tonnes per year in 2050. If the proportion of non-renewable woody biomass sourced for woodfuel is assumed to be 80 per cent on average, in line with the CDM default values discussed above, net CO_2 emission reductions would be 277 -393 million tCO_2. But there is considerable uncertainty about this proportion.

An alternative approach is to distinguish between urban and rural areas and between fuelwood and charcoal. It is reasonable to assume that a high proportion of woodfuel consumed in urban areas involves depletion of natural forest resources because of the concentration of high demand in a relatively small area.

[50] The CO_2 emission factor for charcoal combustion in cookstoves and for production is about 6 times higher than that of firewood on a weight basis but is roughly the same on a m^3 of wood input basis as approximately 6 m^3 of wood is used to make 1 tonne of charcoal.
[51] According to FAO 2012b 1.38 m^3 of wood fuel equates to 1 tonne.

While some adjustment in the form of tree planting might be expected, this is unlikely to be rapid enough. Woodfuel consumed in rural areas is more likely to be from renewable sources because of dispersed demand over a large area. It could also seem likely that rural consumption of charcoal is from non-renewable sources because it is a traded product and not for subsistence. As can be seen from Table 11, the assumptions made for our green economy intervention scenarios have the effect of reducing the share of urban and rural woodfuel and of rural charcoal compared to the BaU scenarios and hence the non-renewable fraction of woodfuel. Table 12 shows the estimated net CO_2 emissions for these different assumptions about the non-renewable woodfuel fraction including the 10 per cent assumption of Habermeyl (2007). Emission reductions range from 19 million tonnes to 242 million tonnes of CO_2 per year in 2030 and 40 million tonnes to 562 million tonnes of CO_2 in 2050. However, the volume of emission reductions is also greatly influenced by the estimation of the BaU scenario as this provides the reference point from which the reductions are estimated.

Table 12 Net CO_2 emission reductions and the non-renewable woodfuel fraction

Assumptions about non-renewable fraction of woodfuel	Net CO_2 emission reductions (mn t) in Green Economy Scenario*			
	2030		2050	
	From Bau1	From BaU 2	From BaU 1	From BaU 2
100 per cent non-renewable	193	242	395	562
70 per cent non-renewable	155	193	316	449
Urban woodfuel and rural charcoal non-renewable	132	172	272	419
Urban woodfuel non-renewable	113	149	237	379
10 per cent non-renewable	19	24	40	56

*Improved charcoal production and improved cookstoves
Source: Own calculations.

4. Discussion and conclusions

4.1 Key findings

This report has set out to examine the role of forests and forest stakeholders in a green economy transformation in Africa. It has shown that Africa's forests can contribute to a green economy in many ways, directly and indirectly. But their potential is not being fully realised.

Current forest use and management presents a mixed picture in terms of the different goods and services sought from a green economy:

Wood and fibre production which tend to be the focus of economic policy-making and of official economic statistics is declining relative to other sectors. There is a failure to shift to value added processing that could significantly increase the economic contribution of these activities. Moreover, import dependence is increasing. Only a small proportion of Africa's production forests can be considered sustainably managed but this has increased over the last decade.

The most important use of forest resources from the perspective of the population in Africa is as an **energy source**. Woodfuel is used by over 60 per cent of the population for cooking and generates 29 times as many jobs as the forestry/wood products sector (FAO, 2014a). But current approaches to woodfuel management raise environmental and social concerns about pressures on the forest resource, poor working conditions and low returns for those involved in collection, and indoor air pollution.

Non-wood forest products other than woodfuel contribute a sizeable amount to GDP, equating to about one third of the amount generated by wood and fibre production (FAO, 2014a) as well as providing important livelihood needs in food, health, and culture. They are rarely sustainably managed and are threatened by deforestation and forest degradation.

Forests also provide **regulating, supporting and cultural ecosystem services** that are important for human wellbeing and underpin a range of growth sectors but these tend to be under-reported and given low priority as a result. At present the ability of forests to regulate climate is in the limelight and considerable investments have been made in REDD+ readiness. Other ecosystem services are important but are less well documented as they challenging to quantify and express in monetary terms. Nevertheless, various studies have estimated that the value of these other ecosystem services could be significant.

Given the likely population increase in Africa and the high expected growth rates, the demand for forest goods and services will increase considerably. For wood, it could be two to three times current levels by 2050. To meet such demand from the existing natural forest designated for production, will require harvesting intensities well above sustained yield, putting severe strain on the forest resource base, already threatened by pressure from agricultural expansion. This could be exacerbated also by localised shortages of woodfuel. Although continued increase in production from planted forests is expected, this will not be sufficient to stem the shortfall in supply. If the natural forest resource base continues to decline as a result of deforestation and degradation from logging, it will become more and more difficult to meet demand without drastically increasing import dependence. This is likely to lead to a greatly reduced forest sector with lower employment, much greater import dependence and replacement of wood by other materials that may be more environmentally damaging. The effect of this high level of demand and the pressures from other sectors, agriculture particularly, will have a deleterious effect on the ability of forests to deliver key ecosystem services - carbon emissions will increase and biodiversity will be threatened as harvesting intensity exceeds key levels.

Three types of GE forest intervention engage and appeal to different stakeholders. Many have been tried in various locations in Africa and provide glimpses of the potential of forests to contribute to a green economy transformation. Interventions focused on managing, enhancing and restoring **natural capital,** have shown that it is possible to meet high environmental standards of SFM in both natural forests and planted forests. It is perhaps more difficult to manage social relationships and ensure lasting benefits for local communities. Results of interventions to date have been mixed. Lessons need to be learned and adjustments made along the way. Another group of interventions have demonstrated that there is considerable scope to increase **resource efficiency** in tree-planting, wood processing, charcoal processing and cooking stoves, through new technology, improved handling and storage practices and supply chain organisation. This can reduce pressure on forest resources. The challenge is in securing high levels of uptake and overcoming financial constraints. **Sustainable consumption** interventions are reinforcing the other two types, driving improvements from the demand side, often as part of international regulatory or supply chain initiatives and to a lesser extent in the form of local demand initiatives to promote sustainable locally produced goods made from wood or NWFPs. Organic and fair trade labelling of natural food and health products is helping to generate incomes from NWFPs for some of the more marginalised groups in Africa.

GE measures can enable African forest stakeholders to better meet growing demands. Our green economy scenario analysis has explored the potential effects of some of these interventions when scaled up. Sustainable management of natural forests, at a harvesting intensity compatible with sustained yield, increases the likelihood that the forest resource base will be maintained. But by 2030, and 2050, the demand for industrial roundwood is projected to be so high that the forest resource base may not produce enough to meet demand. However, when SFM in natural forests is combined with in a package with other green economy interventions, the shortfall in wood supply is greatly reduced, or eliminated altogether, depending on the scenario and associated assumptions. These other interventions includes expansion in the area and productivity of planted forests, increase in the efficiency with which wood is processed, and reduction in deforestation primarily by addressing low agricultural productivity. This package of interventions would therefore help to secure the future of the forest sector and its contribution to GDP and employment. Similarly, woodfuel interventions to improve technology can reduce wood demand, relieving pressure on wood resources in areas of localised shortages but also result in significant benefits for low income families, women and girls particularly, from reduced pollution-related health effects and time savings in woodfuel collection and cooking.

4.2 The importance of context

A package of natural capital and resource efficiency interventions can in theory ensure the future of the forest resource in Africa while meeting increasing demand for wood. It would do this without major compromise to the other contributions of the forest resource to a whole range of growth sectors. This is the key message from our scenario analysis.

In practice there are considerable obstacles that need to be overcome for the interventions reviewed to bring about a green economy transformation. These interventions are mostly small-scale and/or have required several years of effort and financial and technical support from a range of stakeholders to enable them to get established. The institutions and financial mechanisms have not evolved to support them. For example, the forestry sector in Congo Basin countries received support from several French cooperation agencies totalling €120 million over a period of 20 years. This played a major role in the adoption of forest management plans and the move to FSC certification (Corbier-Barthaux, 2012). But even with this level of support, challenges remain. The countries of the Congo Basin have not developed a long–term vision for the forest sector and do not have requirements for results and outcomes monitoring. The governments have not bought in to the management plans and the forest authorities do not make use of the information on the forest resources that is generated by the forest management plans (*ibid*).

Many of the interventions are obliged to work around an unfavourable legislative and institutional framework which overrides informal or customary access rights to forests and tends to disenfranchise local forest users. Where legislation has been introduced to rectify this situation, as in Kenya's charcoal groups and community forestry in Cameroon, it has not been an instant panacea or source of empowerment. This important change is only the beginning and it needs to be backed up by other measures – awareness raising, capacity building, and financial support.

4.3 Improving the enabling environment

Green economy forestry is largely a matter of developing and exercising the right institutions, rules, coordination, and incentive mechanisms. For scaling up and replication to take place so that interventions are more than mere glimpses of green economy potential, actions need to be taken to improve the enabling environment and to address the obstacles that go beyond the local context.

Improved forest governance through wider stakeholder participation

A fundamental step in improving forest governance is for forest stakeholders to have the representation, voice and opportunities for open dialogue on a vision for the future of the country's forests that makes clear the win-win opportunities and tradeoffs in the provision of all types of forest ecosystem services. This requires a broad definition of 'forest stakeholder' to encompass informal users of forest resources and to recognise that users of forest ecosystem services may be in non-forest sectors such as tourism and agriculture. Equitable multi-stakeholder processes are needed that give recognition to local people's traditional claims to forest resources ensuring that these local forest stakeholders have a place at the table. Different levels of government also need to be involved. Processes followed for the VPAs and for REDD+ provide an important precedent and base on which to build.

Work towards local control and new models of engagement with local people/forest communities

International multi-stakeholder processes such as The Forest Dialogue have discussed the possibility that the answer to building sustainable economies in forests lies in the formation of a thriving SME sector, in which the rights-holders (i.e. local communities) hold a meaningful stake (Elson, 2012). While this may not be relevant or feasible in all areas, there is a need to explore a wider range of models for engagement with local people in forest areas. The standard model whereby forest product companies are allocated forest concessions or lease land from the government for plantations, and at best reach some CSR arrangement with the local informal land and resource users, is not robust. It often does not deliver benefits to local communities, it is vulnerable to social conflicts, and reputational risks and as a result can have difficulty in attracting finance.

Other options and models need to be considered that involve a higher degree of local control – such as partnerships between companies and community-owned forest enterprises or promotion of trees on farm. These alternative approaches can take a long time to get established but can pay off as good relationships with local communities are good for business. One of the main constraints to expanding the area of planted forest for industrial roundwood is obtaining appropriate land. Governments and the private sector therefore need to be willing to try alternative approaches to stepping up production.

A more nuanced approach to the informal sector

The quest for new models of engagement with local communities, implies a change in attitude and approach to the informal sector to recognise that there is a spectrum from outright illegal, unsustainable and corrupt activities to those that may be outside the formal law but legitimate because they comply with customary rules and are not so far from sustainable forest management. Instead of branding all of this as illegal and undesirable, governments, private sector and NGOs need to work with actors in different parts of this spectrum in different ways: to diminish the socially and environmentally destructive end of the spectrum through tougher enforcement, and encourage good practice at the other end of the spectrum, by providing or facilitating technology, business and marketing support for informal enterprises and actors in the informal forest sector. This may also point to new purposes and means to formalise effectively.

Improved access to finance

Lack of finance is an obstacle to scaling up green economy interventions. This applies to forestry SMEs, SFM, planted forests, value added processing, cookstove initiatives, marketing of NWFPs and REDD+ projects etc. The unwillingness of banks to lend or private investors to invest is usually a reflection of the policy and institutional environment in which the initiative is operating as well as the more specific risks and returns associated with the interventions. Public investment is needed to improve the investment climate, for example by increasing transparency. Actions being taken as part of the VPA process to improve governance and to promote multi-stakeholder participation in discussions on legality in the forest sector may have a positive effect on perceptions of country risk. Similarly, it has been suggested that a concerted effort in a country to apply REDD+ safeguards could have the effect of boosting investor confidence (Christophersen, 2015).

There is a role for public finance to cover the costs of so-called 'enabling' investment – to address these obstacles so that asset investment (that seeks a return) can take off (Elson, 2012). In the context of forestry SMEs, such enabling investment can for example cover the costs of technical expertise and business mentoring (where enterprises do not have a track record), targeted capacity-building and training and setting up special equity funds that can take an equity position in small forest enterprises to enable them to meet the percentage own funding required for bank loans (*ibid*).

Intersectoral coordination

As forests affect and are affected by a number of sectors beyond the forest sector, notably agriculture, energy, infrastructure and mining, coordination between sectoral authorities and between different levels of government is important. As demonstrated in the context of charcoal, government institutions often have overlapping responsibilities which can create confusion (Godfrey Wood and Garside, 2014). Policy measures beyond the forest sector will therefore be as important as policies within the forest sector. Coordination can help to ensure that interventions reinforce each other rather than undermine. Innovative approaches to exploit synergies between the forest sector and other sectors will be especially valuable. In this respect, some REDD+ programmes are showing the way by linking measures to improve agricultural productivity with reduction of forest encroachment.

Improved information on forest assets

Economic policymaking has tended to focus on the production of wood and fibre without fully appreciating the other economic contributions that forests make. Forests need to be reflected in national accounts and expenditure control review processes, but better information is required for this. Publicly supported research on forest ecosystem services can help by documenting the contribution made by **forest ecosystem services** to different sectors and livelihood systems. This will raise awareness about how forests provide an ecological foundation for GDP in many sectors, and the range of forest stakeholders and management types that can sustain it. This is the kind of information needed to support the leaders of inclusive forest green economies.

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Acronyms

AAC:	Annual allowable cut
BaU:	Business as usual
CDM:	Clean Development Mechanism
CSR:	Corporate social responsibility
ER PIN:	Emission Reduction Project Idea Note
ES:	Ecosystem services
EUTR:	European Union Timber Regulation
FAO:	Food and Agriculture Organization of the United Nations
FCPF:	Forest Carbon Partnership Facility
FLEGT:	Forest Law Enforcement Governance and Trade
FSC:	Forest Stewardship Council
FTE:	Full-time equivalent
GHG:	Greenhouse Gas
IEA:	International Energy Agency
IMF:	International Monetary Fund
ITTO:	International Tropical Timber Organization
IUCN:	International Union for Conservation of Nature
MAI:	Mean Annual Increment
NWFP:	Non-Wood Forest Products
PFE:	Permanent Forest Estate
REDD+:	Reducing emissions from deforestation and forest degradation
RWE:	Roundwood Equivalent
SFM:	Sustainable Forest Management
SME:	Small Medium Enterprise
SSA:	Sub-Saharan Africa
UNEP:	United Nations Environment Programme
VPA:	Voluntary Partnership Agreement

Africa is achieving high GDP growth rates but still faces challenges to reduce poverty and create sufficient jobs. As Africa's economies are highly dependent on natural resources, the ability to generate growth in the future and meet wider development priorities will depend on what happens to key resources like forests. For this reason green economy approaches are increasingly relevant to Africa. This report explores the role of forests in a green economy transformation in Africa. Its aim is to present policymakers with a strong rationale for linking forests and REDD+ planning with green economy planning and investments.

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