CHAPTER 4: FORESTRY IN TROPICAL AFRICA

- Introduction
- State of forestry in tropical Africa
- Logging impacts, problems and challenges
- Interventions and responses

Courtesy of Global Witness

CHAPTER 4: FORESTRY IN TROPICAL AFRICA

Chapter summary

Forestry is the science, art and industry of managing forests and tree plantations. Foresters seek to obtain a wide variety of products and services, including timber, woodfuels, protecting water catchments, conserving habitat for biodiversity, and sequestering carbon. This chapter focuses on the first of these: managing forests and plantations to procure timber, and the impact that this has on Africa's tropical forests.

Timber harvesting, or logging, is an important industry in many tropical African countries. Timber concessions in Central and West African countries cover an area of forest roughly the size of Sweden, but the volume of timber harvested by the formal logging sector is far outweighed by the informal sector – the harvest of timber that is unregulated and often illegal. Logging degrades forests significantly. The felling and extraction of timber trees causes significant collateral damage to surrounding trees and plants during felling and extraction. Indirect effects of logging also cause forest damage: road building and forest thinning can open up previously remote areas of forest to charcoal making, agricultural expansion, hunting and settlement.

This chapter identifies three priorities:

- **Converting logging concessions to forest conservation and restoration areas.** The rise of REDD means that protecting large areas of tropical Africa's forests within timber concessions could potentially become competitive with logging them, in terms of the revenue generated for governments.
- **Supporting timber plantations for domestic markets.** Plantations dedicated to meeting the vast domestic demands in tropical Africa for timber and woodfuels could help ease pressure on forests and free them up for carbon conservation.
- **Conserving forests delivers a better outcome for forest carbon than 'sustainable use' options.** If the opportunity exists to fully protect a natural forest, then it should be protected.

1. Introduction

The first hurdle for donors and funders peering into the world of forestry is that the meanings and definitions of terms commonly used – *forestry, forests, intact forests, secondary forests, production forests, Sustainable Forest Management, sustainable forestry, plantations, community forestry, illegal logging, informal logging, forest conservation* – are anything but straightforward (see Box 1 for a glossary). To add to the confusion, many are used interchangeably: forestry is often employed in the REDD context as a proxy for forest conservation, for example.

What is the purpose of forestry? The short answer is that it is to extract wood-based products from forests for human benefit. Or, as Jack Westoby famously declared more than thirty years ago, *'forestry is concerned not with trees, but with how trees can serve people.'*[1, 2]

Are forestry and forest conservation and restoration similar or different activities? They are not the same: the end product of all forestry is always a felled tree, whereas forest conservation and restoration seeks to achieve the opposite: securing the ongoing life of a forest without logging.

1.1 The theory of 'wise use' and sustainable forestry

If forestry always results in loss of trees, does it then follow that forestry is always harmful in terms of carbon emissions? And if it is, should we be aiming to eradicate forestry, as we seek to do for poverty and infectious diseases? These are tough and seemingly intractable questions. It is easy to assume that forestry (like fishing, agriculture and mining) cannot and should not be viewed as an environmental ill to be remedied, because the requirement for timber and other wood-based products is a basic human need, right across the global economy.

From this perspective, the goal should be to regulate the extraction of wood products so as to minimise ecosystem damage while meeting global demand. This in turn derives from the 'wise use' and 'sustainable utilisation' worldview that has dominated the forestry industry, multilateral institutions (eg, the World Bank) and bilateral development Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ), Agence Française de Dèveloppement (AfD) for more than four decades.

Supporters of wise use argue that forestry practices can achieve sustainability, through two principal models: *Sustainable Forest Management (SFM)* and *plantations*. SFM (which embraces the related concept of *forest certification*) aims to log forests selectively (extraction of some but not all trees from a given forest area) thus ensuring *renewability* – new trees will grow to replace those that are removed. Plantations (sometimes referred to as *planted forests*) are promoted as renewable sources of timber and wood products that also reduce reliance on natural forests for those materials, and sequester carbon in the growing phase (and, subsequently, to some extent, in wood products, eg, in the construction industry).

1.2 Problems with sustainable forestry theory and practice

Research for this report identifies forestry as the most problematic of all the drivers of deforestation and degradation, both globally and in tropical Africa, although it does not follow that it is the leading cause (see the **Agriculture** and **Woodfuels** chapters). The key difficulties are summarised below.

1.2.1 Disagreements and lack of consensus

One overriding concern is the profound level of disagreement and lack of consensus surrounding forestry, stretching from disputes over the definition of forests through to different views on positive and negative impacts of the key forestry activities. The lack of consensus on where and how forestry should or should not be practised has created a context in which there is great uncertainty on the best way forward, which in turn hampers the ability of donors and funders to identify strategies and projects to support. Claims and counter-claims are made for the range of forestry interventions, often without robust and defendable evidence.

Box 1: Forestry glossary

Forestry: the science and practice of managing forests to provide a wide range of products, services and benefits, including timber, wildlife conservation, ecotourism, water catchment preservation, carbon sequestration, food, woodfuels, alleviating poverty, and protecting sites of religious and cultural significance.

Primary forest: a forest that has been largely untouched by human activities.

Secondary forest: a forest that has been affected by human activities; commonly used for forests that have experienced some level of logging. 'Recovering secondary forests' are those that are regenerating.

Plantation: a stand of planted trees, often a monoculture (single species), exotic (non-native), densely planted and managed to maximise output of specific products – timber, wood chips, pulp for paper manufacturing, woodfuels, biofuels – or services, eg carbon sequestration, watershed protection, holding back desertification.

Clear felling/cutting: logging method in which virtually all trees are felled, and perhaps other vegetation cleared – more common when trees are of low value for timber (agricultural expansion, wood chipping, charcoal).

Selective logging: logging method in which only particular species are targeted for high value timber. Most logging in the tropics is carried out in this way, although it can be more or less 'selective' depending on the prevalence of suitable or valuable timber trees and the state of transport infrastructure – from about 8–15 trees per hectare in South-East Asia, to 1–5 trees per hectare in Latin America and Africa.[3]

Rotation: refers to the time between harvests in both forests and plantations. Rotation lengths in concessions in Africa are usually around 30 years. Lengthening the rotation time aims to improve sustainability in selective logging operations by giving the forest enough time to return to previous forest structure and carbon stocks.

Sustainable Forest Management (SFM): encompasses a broad set of principles that aim to sustain an efficient supply of products from a forest (whether timber, food, woodfuels or other products) while preserving forest biodiversity and ecosystem services, and also alleviating poverty and protecting rights of forest-dependent peoples.

Reduced impact logging (RIL): central component of SFM; a set of logging practices that aim to reduce the damage that felling and extraction can inflict on surrounding trees and other plants.

Community forestry: encompasses various models that involve granting ownership and/or management rights over forest resources to people living around forests. Often entails the community developing and implementing a management plan, which aims to ensure the sustainable and profitable use of the forest, as well as conservation zones. Practiced under various names in different countries – participatory forest management (Tanzania), forêts des communautés locales (DRC), etc.

Concession (or timber concession): an area of forest in which a government has granted a timber company temporary rights to extract timber, while maintaining ownership over the land. Concessions can be leased for decades, and the contract with the timber company can restrict the annual amount of wood that can be harvested and oblige companies to deliver benefits to local communities (building schools, sharing profits, providing employment, respecting special sites, etc).

Timber products: includes logs in their unprocessed state, but also processed products such as sawnwood, plywood and veneer.

1.2.2 Forest gains and losses from forestry

To what extent is forestry responsible for forest gains and losses? At a global level, forestry can claim some success as a route to increasing tree cover and carbon storage.[4, 5] In China, for example, plantations have massively expanded the land area covered by trees, thus contributing significantly to removal of carbon dioxide from the atmosphere. But this trend is not uniform, and net forest loss is still occurring across much of the globe.[6] The view on gains and losses is also affected by the debate on natural forests versus plantations (see below).

The expansion of plantations also masks the extent to which forestry has caused very extensive damage to natural forests globally. As we saw in **Chapter 1**, two estimates put the global area of degraded forestland at 850 million to 1 billion hectares, equivalent at the higher end of the range to the land area of the entire United States.[7, 8] Logging by the forestry industry (both conventional and selective) has been a prime cause of that degradation, resulting in up to 50 per cent losses of aboveground forest carbon. From this perspective, forestry looks completely unsustainable.

1.2.3 Natural forests versus planted forests (plantations)

Plantations are counted as forests in many estimations of forest cover, and also (controversially) in some forest certification schemes. Some of the disputes over the validity and utility of plantations arise from this definitional blurring. One of the consequences is a degree of unwarranted complacency on the state of natural forests in countries with extensive plantations: when treated as equivalent, the plantation contribution to a net increase in forest cover can mask decline and degradation in natural forests.

Other dangers inherent in perspectives that treat planted forests as equivalent relate to ecosystem properties and values. Natural forests are, in general, more resilient to fire, drought and disease, and more water retentive; they are also closer to a state of permanence, because the end goal is continuance of the forest rather than felling and replanting; and they are far superior to plantations as homes for biodiversity.

The other side of the debate is that plantations are essential as producers of timber and other wood-based products: without them, demands on natural forests would be considerably higher. They are also seen by many as a core component of the forestry response to emissions mitigation.

Our overall finding is that the need to balance all these factors is often lost in debates over planted forests, with proponents frequently taking a fixed 'for or against' position. In tropical Africa this has led to a lack of critical scrutiny of the export-based business model of many plantations, and the need for more plantations that meet domestic demands for timber and wood energy.

1.2.4 Sustainable Forest Management (SFM): a positive or negative approach?

SFM is the de facto forestry approach advocated by many international institutions, donor agencies and governments. Often used imprecisely, SFM refers to a broad range of practices that aim to sustain a productive supply of products from the forest while reducing the impact of extraction, and also improving the social and economic benefits to local communities.[9] The term can be used to refer to many different forest uses, from logging in timber concessions to the production of other forest products such as honey, rubber or woodfuels. In this chapter we look solely at SFM in the logging and carbon context, within which there are two main elements:

- **sustained timber yields (STY)** – limiting the timber harvest to trees of a particular size, or to a number of trees (or volume of wood) per hectare, with the aim of maintaining future yields of key commercial tree species; and
- **reduced impact logging (RIL)** – a variety of logging techniques that aim to reduce collateral damage to surrounding forest during the felling and tree extraction process, including: minimising the width and density of logging roads; cutting away vines and lianas from target trees, which can tangle the canopies of multiple trees together; controlling the direction of felling to minimise damage to other trees; and disallowing timber felling near streams or important water catchments. RIL is often used interchangeably with **selective logging**.

SFM is the subject of intense debate within the broad community of organisations working on forestry issues (see below for more detail). The headlines are that SFM in tropical Africa currently results in a 5–20 per cent loss of forest carbon (relative to undisturbed natural forest). This is a significant level of loss, which calls into question the use of the term 'sustainable'. If SFM logging models employed in South-East Asia are applied in tropical Africa, the loss could rise to as much as 50 per cent.

Proponents of SFM argue that the loss represents an improvement on 'business as usual' logging, which in its most extreme form can see clear cutting (the loss of all trees) and thus a 60–80 per cent loss of aboveground biomass. Other planks in the defence of SFM include the argument that it is preferable to conversion of forests for agriculture.

This report concludes that the carbon losses incurred by the SFM approach are significant, and often ignored because of the reduction in emissions relative to conventional logging. It also finds that SFM is being normalised and institutionalised within the REDD-plus process, without sufficient consideration of options that do not involve any logging, such as REDD-plus conservation and restoration areas. In effect, SFM is legitimising logging, at exactly the point where full forest conservation and restoration should be the leading global priority for tropical forests.

1.2.5 Poor comparative analysis of forestry practices

The **ProForest** report (see **Annex 1**) found that there is a serious dearth of comparative analysis of forestry practices. The consequence is that there is a very poor understanding of the carbon gains and losses that result from different forestry activities. This in turn leads to unsubstantiated claims on the efficacy of forestry interventions. A particular worry is the lack of scrutiny of the extent to which forestry theory translates into practice. Given the seriousness of the forest carbon challenge within the overall climate change context, there is a high risk of ineffective (or even highly damaging) practices receiving significant support and funding. This is untenable, and the need for a comprehensive body of new analysis to resolve many of the disputes on carbon gains and losses should be a top priority within the forest research community.

1.2.6 Are forests renewable resources?

As we explored in **Chapter 2**, natural forests are both sinks and sources, drawing carbon dioxide down from the atmosphere and storing it in biomass, and emitting CO_2 as part of the carbon cycle as well as when they are deforested and degraded. They are also inherently renewable when left undisturbed: trees die and their biomass is absorbed into the soil, and new trees grow through natural seed dispersal and germination processes.

But the renewability attributes of natural forests have, paradoxically, proved inimical to them. Logging can be sanctioned because of complacency that forests will naturally recover and renew themselves. High levels of degradation are tolerated for the same reason. Renewability will only occur if damaged forests are allowed to fully recover: logging can cause forests to lose their resilience and regenerative capacities if too many removals are made, and too much collateral damage is inflicted.

As with other disagreements on forests, there is a poor understanding of tipping points – at what stage of degradation does renewability morph into irreversible forest loss? In the absence of clear research, caution and conservatism on renewability potential should be the default position.

1.3 Forestry versus conservation

Should donors and funders who want to achieve forest conservation and restoration goals support forestry as a means to that end? At a fundamental level the answer is unequivocal – there is a better option. If the opportunity exists to fully protect a natural forest, then protect it. In practice, virtually no SFM regime or plantation model

can compete with a natural forest in terms of carbon storage in the long term, assuming the forest can be left undisturbed. This applies equally for many degraded forests: left to themselves, some will regenerate naturally, if the core ecosystem requirements (soil, rainfall, adequate animal and plant biodiversity) are still in place.

Forest conservation and restoration is highlighted throughout this report as the primary REDD-plus intervention in tropical Africa for a range of reasons. Where implementation is possible, forest conservation and restoration will deliver both avoided deforestation and a reversal of degradation. This in turn will optimise the REDD-plus contribution to climate mitigation, through reduced emissions and increased carbon storage. It is also highlighted as a corrective to one of the prevailing currents in the debate on REDD-plus options: the assertion that forestry is a viable alternative to forest conservation. Forestry can play a part, but it cannot be the principal delivery agent.

While the arguments on the role of forestry versus forest conservation need to be rehearsed in order to understand the overall background, they can have a dangerously distorting effect. What makes sense at a theoretical level may look quite different in practice. Demand drivers vary enormously from one tropical African forest to another, as do local physical, environmental, social, economic and political conditions.

The caveat is that while implementation of full forest conservation and restoration is the leading REDD-plus priority, it is not the sole response required. Other interventions are also necessary. This is because human needs drive activities in tropical Africa that result in deforestation and degradation – woodfuel collection, charcoal production, conversion of forests for agriculture, and timber, mineral and oil and gas extraction. These needs will not evaporate: answers must be found that balance REDD goals with other imperatives.

Once demand factors are put into the mix, the potential role of the forestry sector in achieving REDD goals in tropical Africa becomes clearer. To some extent this is a matter of appropriate expertise. The core competence of forestry is the production of timber and wood-based products. Plantations dedicated to meeting the vast domestic demands in tropical Africa for woodfuels, charcoal and timber will ease pressure on forests and thus improve the efficiency of forest conservation.

1.4 The way forward for forestry in tropical Africa

Is forestry in tropical Africa currently configured to focus principally on plantations that serve domestic demand? In broad terms, the answer is no. Rather than an orientation toward plantations, efforts are largely concentrated on revenue generation, sustainability of the production base and considerations of social and economic equity.

As a result, the near future could see a rapid expansion and growth of export-led industrial logging and plantations across the region, and some forestry outputs for domestic markets. Regulatory regimes for the sector are likely to be reformed to increase taxation and tax collection from forestry companies, and to improve the distribution of benefits, for example by mandating many forested areas for community and small-scale forestry. The aim of many in the sector is to ensure the sustainability of the production base through a combination of selective logging practices and export-oriented plantations.

Revitalisation of the sector along these lines is far from hypothetical. A global rebound in demand for wood products, agricultural commodities and biofuels would stimulate output, and stronger democracy in many tropical African countries is laying the basis for more effective forestry sector regulation and enforcement. And the core condition for such an expansion is already in place – the existing logging licenses granted to forestry companies for millions of hectares of forest across tropical Africa. The bulk of these licenses or forest concessions are currently dormant: logging activity has been mothballed, while timber companies wait for an upturn in prices.

This is the forestry sector landscape within which forest carbon and forest ecosystem protection and enhancement have to compete. Can forestry in tropical Africa accommodate these new priorities, without jeopardising economic and social goals?

Whether the logging and other wood and plant-based removals are carried out by industrial/commercial logging companies, smaller-scale forest enterprises, illegal or informal loggers, community forestry programmes or basic demands for wood-based heat and light, they all depend on and exploit the physical resources of the forest. The complexity of forestry and its connection to deep social and economic issues in the region should not obscure or diminish this basic fact.

The plantation component is more complex and controversial, and splits into three subsets: woodfuels, timber and biofuels. Proponents argue that the benefits of plantations are three-fold: they provide sorely needed revenues for tropical African countries; the outputs from plantations go on to play a climate mitigation role through carbon storage in building materials, other semi-permanent products and as energy alternatives to fossil fuels; and plantations sequester carbon as they grow.

The counter-arguments (in climate terms) are that timber and biofuel plantations produce a range of negative consequences. Where natural forest is cut down to make way for plantations, critical forest ecosystem services (including freshwater resources, rainfall generation capacity, habitats for biodiversity and permanent carbon storage) are lost. However, the counter to this is that plantations can be sited on marginal (disused or derelict) land and thus they can reduce pressure on natural forests rather than compete with them.

The danger with this debate is that it is too theoretical. The balance of factors plays out differently across the tropics. In tropical Africa, these arguments ignore two fundamental issues: the pressing needs of large numbers of people in tropical Africa for wood-based energy (fuelwood and charcoal) and timber. This signals an urgent requirement for plantation forestry to reposition away from export to domestic markets, as we argue below and in the **Woodfuels** chapter.

Perhaps the key to a REDD-friendly future for forestry in the region is that while the sector is important to Africa's economy, it generates nothing like the revenues and foreign investment of the mineral and energy extraction industries. Africa's actual share of the global forest products market is small and even smaller in terms of value added. Creating true REDD-friendly alternatives to the sector, therefore, is by no means impossible. Unlike in the extractive sector, it is not implausible to think of avoided extraction interventions which add value in economic terms as well as leading to forest carbon and forest ecosystem protection and enhancement.

Yet such opportunities may not exist indefinitely. Much of the demand for wood in Africa is driven by domestic needs (local people who need light, heat and building materials, for example) and such pressures will increase as Africa's population grows rapidly. Avoiding exports to the EU, and even China and India, may be possible but ignoring the needs of the domestic market in tropical Africa is not. Unless measures are taken to secure the timber and fuel they need from more carbon-friendly sources, any interventions are likely to fail.

Fundamentally, if protecting and enhancing Africa's forest carbon is the goal then the current condition and nature of forestry in the region offers huge potential opportunities. The undeveloped nature of the industrial forestry sector offers scope for converting dormant logging concessions to new large-scale REDD areas, within which 'forestry with a social purpose' could be practised as a means to meet domestic needs, alongside extensive 'no-logging' zones.

1.5 Goals and strategic priorities

In overall terms, we see two main goals for donors and funders: curtailing the expansion of industrial logging in the region, and repositioning the forestry sector to meet domestic timber and wood-based energy needs. These lead to two key priorities: an expansion of timber and woodfuel/charcoal plantations (see the **Woodfuels** chapter) serving domestic markets; and conversion of dormant logging concessions to large-scale REDD-friendly forest areas.

Forest conservation and restoration are better options for carbon than forestry. From the perspective of protecting forest carbon, if the opportunity exists to fully protect a natural forest then donors and funders should pursue this option. In practice (and in the longer term) virtually no selective logging regime or plantation model can compete with an intact natural forest in terms of carbon storage. This applies equally for many degraded forests: left to themselves they will regenerate naturally, if the core ecosystem requirements (soil, rainfall, adequate animal and plant biodiversity) are still in place.

Converting logging concessions to forest conservation areas. Across 6 Central African countries, 133 million hectares of forest are currently designated as 'production forests' – areas where logging could be permitted. This is more than twice the size of Spain. Of this total, about 40 million hectares have been assigned to specific logging companies through the concession system.[10] If activated for logging, these would spew out vast emissions. The emergence of REDD means that forest conservation has the potential to compete with industrial logging as a revenue earner. Our preliminary calculations (see below) suggest that REDD could be competitive with industrial logging in some Congo Basin countries. There is a real opportunity here for donors and funders to lead the way.

Developing timber and woodfuel plantations for the domestic market. Plantations dedicated to meeting the vast domestic demands in tropical Africa for timber and woodfuels could ease pressure on forests and free forests for carbon conservation. Our preliminary calculations, using Tanzania and Uganda as case studies, suggest that meeting national timber demand with plantations could be achieved with a land area equivalent to only 5–20 per cent of the forest area required to meet demand.

Other priorities include support for regulatory regimes in the forestry sector such as FSC certification or improved filtering out of illegal timber exports via the FLEGT initiative (see below). But these gains will only have a marginal impact if the fundamental domestic demand drivers are not addressed. Community forestry has a very mixed track record across different countries, but it may hold potential to reduce deforestation in areas with high population levels. Similarly, SFM approaches may bring greater efficiency in logging and processing, and while that is desirable it should not be seen as a conservation solution.

2. The state of forestry in tropical Africa

The state of forestry in tropical Africa varies in scale, nature and impact from country to country. Even in countries that share similar characteristics and socio-economic conditions, different local customs or policies combined with wider regional pressures can produce significantly different situations and issues.

But some broad observations are still possible: commercial logging dominates in terms of land use (ie, the actual amount of land set aside for each activity) but domestic demand, largely for woodfuels, dominates in terms of wood removals. In addition, much of this domestic demand is illegal or informal. Partly because of this, and also because of a lack of systematic studies, data on forestry in Africa is notoriously unreliable.

From a national and regional perspective, forestry does not have the same economic impact as the extractive industries. Not only is the global timber industry dwarfed by the mining and energy sectors but also Africa is a small player on the global market. The formal direct contribution of the forestry sector to the wider economy is relatively modest – even if allowances for illegal logging are made. This may change, however, in the future as domestic and international demand increases – China's demand for African wood alone has grown very significantly in the last ten years.[11]

The current situation therefore creates both clear opportunities and challenges: is there potential, given the growing global demand for forest carbon mitigation and forest ecosystem conservation, and the current lack of development in the industrial forestry sector, to increase the total area of conserved forest in Africa? Yet to make this opportunity viable, the timber and woodfuel needs of the domestic market in tropical Africa will have to be met from safe and sustainable sources.

2.1 A brief history of forestry in tropical Africa

As in all forested areas of the world, local communities in the region have relied on forests for their livelihoods for millennia, cutting down trees for woodfuel, charcoal and timber, harvesting other forest products, and clearing areas of forests in order to plant crops. *Community forestry* and *small-scale forestry* are models that have evolved out of these practices. Much of the logging that goes on in Africa's vast *informal forest sector* comes under this heading, including extraction for essential livelihoods purposes that is often technically illegal.

Large-scale commercial logging for export markets began in the colonial era, accelerating after the Second World War, particularly in the early post-independence years. This led to the development of an industrial forestry sector in West, Central and East Africa, often supported by financing from international institutions such as the World Bank and the IMF, who saw export timber revenues as a key driver of economic development. By the late 1980s, evidence had mounted that industrial forestry had largely failed to deliver economic benefits equitably, enriching a few at the expense of the many. A number of leading governmental donors, including Norway, Finland and the UK, responded by supporting approaches that had explicit social justice goals, such as community forestry.

At the same time, concerns over the future production base of tropical forestry were surfacing, mainly in Latin America and South-East Asia, where clear felling or clear cutting (removal of all trees) was causing the complete loss of some forest areas. These concerns looped back to social justice issues, because clear felling was usually carried out in order to earn export revenues – from timber and from the crops that were grown on cleared forestland (including soybean, tobacco, maize and palm oil).

The response of some governments, businesses and NGOs was to develop *sustainability* frameworks for forestry, including *Sustainable Forest Management (SFM)* and *forest certification*. SFM and forest certification have so far had a relatively limited impact on African tropical forests, in part because selective logging is the standard practice in timber concessions – because poor infrastructure and high transport costs mean that it is only profitable for companies to harvest the most valuable timber trees.

While these developments have been going on over the last few decades – the drive to share the economic benefits of forestry more equitably within tropical African countries and the rise of sustainability concepts within the industry – forest conservation has pursued a different track. Led by a small number of international NGOs (including WWF, Conservation International, Fauna & Flora International, Wildlife Conservation Society and The Nature Conservancy) efforts have concentrated on the creation and management of national parks and other protected forest areas across the region, with protection of threatened forest biodiversity (especially primates, birds, reptiles and amphibians) as the goal. Within protected areas, logging (whether commercial, small-scale or informal) is usually either completely or partially prohibited. In some cases, *forest conservationists* have also sought to influence forestry policy more directly, for example through lobbying for the cancellation of logging concessions (licenses to log in a given forest area) that have been allocated to forestry companies by governments. In others, conservation NGOs (often working closely with the same multilateral and bilateral donors that are funding forestry activities) have reached a range of compromises in which some logging is accepted in one part of a forest as the price of securing logging-free zones in another part.

Running alongside all of these activities is the other core component of forestry: the planting of trees. Tree planting is carried out right across tropical Africa, for a wide variety of purposes, including trees for shade and recreation in cities, towns and villages; trees as agricultural crops *(agroforestry)* such as cocoa, coffee and mango; and trees as windbreaks and defences against soil erosion and freshwater loss. In the forestry context, tree planting is largely delivered through *plantations*, usually evenly spaced trees of the same species (often non-native, eg, eucalyptus) that are grown for timber. The term is also used by many in the forestry industry to describe tree growing for biofuel production, such as *oil palm* and *sugarcane plantations*.

Courtesy of Global Witness

Large-scale timber plantation forestry (principally export-led) expanded in the 1960s and 1970s in tropical Africa, but (like logging in the region) the decades of civil instability and structural readjustment that followed led to a tapering down of investment which saw the industrial forestry sector shrink in terms of capacity and output. Biofuel plantations on the other hand have been a relatively marginal component of the forestry sector to date.

2.2 Three types of forestry in tropical Africa

Timber is harvested from Africa's tropical forests in many different ways. These reflect the diversity of forest types across the continent, the value of timber species available and policies and laws affecting harvest and trade. Below we profile three types of forestry: **industrial logging**, **small-scale logging**, and **informal and illegal logging**. These categories provide a basis for comparing each in terms of scale and impact on Africa's forests.[i]

As discussed below, the distinctions between each type of forestry is not clear: many small-scale logging operations are informal, or even illegal, and whether a logging activity is informal or illegal largely depends on the laws of the country in question.

i Sustainable Forest Management (SFM) and plantations are at once current forestry sector activities and potentially beneficial interventions in carbon terms. As such they are both dealt with in the **Interventions** section.

2.2.1 Industrial logging

Industrial logging has several defining features. First, it takes place using heavy machinery and is conducted over very large areas (at least several thousand hectares). Second, it is executed by a clearly identifiable actor (usually a company). Third, the company is usually assumed to be in compliance with forest law and policy.

The history of industrial forestry in Africa begins with the colonial era. The European colonisation of the 19th century, and the ensuing demand for timber as well as tropical commodities (such as palm, cocoa and rubber), changed the face of Africa's tropical forests. In Madagascar, for example, French colonialism from 1896 created deforestation, prioritising coffee cultivation over traditional rice harvesting. In Nigeria, Britain forced local farmers to produce palm oil to lubricate railways and manufacture soap.[12]

The exploitation of Africa's forests begun by colonial powers continued, largely unabated, for much of the twentieth century. This was the period when large-scale logging in tropical Africa began in earnest. Africa's forests were seen as accessible and cheap sources of raw materials and agricultural commodities that could drive the development of newly independent countries. Forest management policies were often rooted in the colonial era and development agencies saw forests as potential solutions to social and economic problems. Equally, from a European perspective, sourcing wood from former colonies was seen as driving the modernisation of the region as well as offering useful raw materials for domestic economies.

Today, industrial logging is still widespread across tropical Africa and is the dominant commercial use of Africa's forests. In some African countries, commercial timber extraction takes place through a concession system: companies enter into a contract with the government – called a concession – in which the state maintains ownership of the forested land, and the company is given the right to harvest timber.

The actual area of forest referred to in the contract is also called a concession. This appears to be the dominant model of industrial logging in Central and West African countries, including Cameroon, the Democratic Republic of Congo, Gabon, Central African Republic, Equatorial Guinea and Republic of Congo.

In general, timber concessions in tropical African countries are granted from between 15 to 30 years, which is considerably longer than in Asia, for example.[13] The process of awarding concessions varies across different countries. Some countries, such as Ghana and Cameroon, use competitive bidding to allocate concessions, the former through public bidding and the latter by invitation. However, most countries do not have a clear and transparent system and, instead, concessions are awarded administratively. This is the case for the DRC, Republic of Congo and Gabon, for example, and such processes can lead to corruption and relatively low levels of revenue.

The size of the concessions can vary significantly (see Table 1). In the Congo Basin, concessions can be as large as 1.8 million hectares but in West Africa their size is typically smaller. In Ghana, for example, some concessions are as small as 15,000 hectares and the largest is around 140,000 hectares. This smaller size of concessions is partly driven by economics – mining concessions and agricultural encroachment offer increasingly tough competition for the logging industry – and the forestry sector in this region is changing to focus on small-scale logging, private forestry, plantations and agroforestry. Demographic pressure also limits the potential size in some areas: in Nigeria, for example, population pressure has led to shrinking concessions which require ever shorter felling cycles to be profitable. In the less developed Congo Basin, however, where poor infrastructure and high transport costs limit the development of the industrial forestry sector, the concessions are large enough to be viable on a relatively long felling cycle.

Concessions often contain clauses designed to regulate the amount of wood that companies take out of forests. Harvesting restrictions often focus on minimum logging cycles and log diameter within concessions, which are broadly similar in many countries. In Cameroon, the felling cycle is set at 30 years for a harvestable area (40–50 years in the CAR, 25 years in Republic of Congo). Minimum diameters are typically 50–60cm (more where there is a management plan). Other regulations seek to restrict the number of trees logged per hectare (10–15 in the CAR). In the DRC, however, concession-based harvesting limits are less specific.[13]

Table 1 indicates the areas of forest in six Central African countries that are already being logged, or have been allocated as logging concessions (but are currently dormant), or are designated as protected areas. The data is staggering, showing the scale of forest destruction that could be unleashed if industrial logging were to be fully activated.

Table 1: Comparison of forest areas gazetted for production, under management and under protection (as of 2006)

(million hectares)	Cameroon	Gabon	Congo	DRC	CAR	Eq Guinea	Total
Land Area	46.5	265.7	34.1	226.7	62.3	2.8	398.2
Dense Forest Area	**21.4**	**21.2**	**25.9**	**124.5**	**8.2**	**1.9**	**203.1**
Production Forests	**10.5**	**19**	**12**	**87**	**3.3**	**1.2**	**133**
Area gazetted for exploitation	7	12	10	22	3	1.2	55.2
Area under forest management	**4.3**	**6.4**	**7.1**	**9.7**	**3**	**0.05**	**30.5**
Preparatory phase	0.8	1.9	1.7	3	0.3	0	6.9
Developing	0.7	1.5	3	6.7	1.5	0	13.5
Submitted	0.4	.0.1	2.3	0	0.7	0.05	3.5
Finalised	3.2	2.8	0	0	.6	0	6.5
Certification in process							
ISO 14001	0	2	3.3	0	0	0	5.3
Pan African Forest Certification	0	0.9	0	0	0	0	0.9
Forest Stewardship Council	0.5	0.3	0.3	1.4	0	0	2.7
Others	0	1.7	0	0	0	0	1.7
Protected Areas	**3.2**	**3.9**	**3.9**	**16.1**	**5**	**0.5**	**32.7**
Strict Nature Reserve	0	0.01	0	0.3	0.08	0.05	0.4
National Park	1.7	2.9	2.3	8.5	3.1	0.3	18.8
Species Management Area	1	0.02	1	1.4	1.5	0.2	5.2
Managed Resources Protected Area	0.4	1	0.5	5.9	0.3	0	8.2

Source: Adapted from Nasi, R., B. Cassagne, and A. Billand, *Forest management in Central Africa: where are we?* International Forestry Review, 2006. **8**(1).[10]

In the DRC, for example, out of 124 million hectares of dense forest, 87 million hectares (about 1.3 times the size of France) are designated as production forests, meaning there is no legal prohibition to prevent the issuance of a logging concession licence. As of 2006, 22 million hectares of forest were allocated to timber companies through the concession system ('area gazetted') – an area the size of Portugal. Since then, the DRC's government has cancelled almost 60 per cent of concession agreements (covering 12 million hectares), following a review sponsored by the World Bank into corruption in the timber industry.[14-17] Taking account of the cancellations in the DRC, currently allocated concessions across the six Central African countries therefore cover about 43 million hectares of forest (slightly more than the size of Spain).

While the aggregate of protected forest areas in the six countries is significant (nearly 33 million hectares – the size of Norway), it is smaller than that currently under timber concessions, and dwarfed by the total area where logging could in principle occur (133 million hectares – roughly equivalent to the land areas of France, Germany and the UK combined). The relatively low net current deforestation rate in these African countries conceals the climate threat implicit in production forests. If all were logged, the carbon emissions consequence would be devastating. Selective logging under current levels of logging intensity could release an estimated 5GtCO_2, equivalent to half of global emissions from all air and ship travel in the world in 2005. If the logging intensity increased to levels currently seen in South-East Asia's forests, as much as 52.7GtCO_2 could be released into the atmosphere – this is equivalent to almost twice the world's total emissions in 2005.[ii,21] (See the **Impacts** section below for more on logging intensity).

ii Conservative calculation based on findings from a study by Brown on the carbon impact of lower intensity selective logging (as found in concessions in Africa)[18], a study by Feldpausch on selective logging in Amazonia,[19] and a study by Putz on the carbon impact of higher intensity logging in south-East Asia.[20] As argued below, it is possible that higher logging intensity could become more prevalent in timber concessions in Africa in the future, if infrastructure is improved and transport costs lowered.

Yet, while the level of forestland reserved for industrial logging in tropical African forests is clearly a major potential emissions disaster, the current direct impact of the industrial forestry sector in the region is relatively modest. In the DRC, for example, the Fédération des Industriels du Bois, a timber industry association in the DRC, believes that only half of the total area under concession (about 10 million hectares) were in operation.[22] The actively logged areas in the DRC, though considerable, are far less than the size of the concessions implies. The reasons for the slow development of industrial logging in Africa are largely economic: poor infrastructure and high transport costs means the incentives to step up logging activity remain poor.

In terms of logging intensity per hectare, because Africa's forests have a much lower density of high value species this makes the systemic extraction of timber in Africa much less attractive and cost effective. In many areas therefore, more by accident than design, a form of selective logging already takes place, which would seem to reduce the carbon benefits offered by SFM programmes or RIL.

2.2.1.1 The corporate landscape of industrial logging

Much of the industrial logging in Africa is carried out by international groups – it is estimated that more than 50 per cent of the forestry harvesting and processing enterprises in tropical Africa are owned by large foreign companies.[23] The vast majority of these are either European or Asian (the latter largely Malaysian or Chinese). The European firms are well established in the markets with strong colonial ties: for example, in the Ivory Coast, the prominent companies are French, Italian and Lebanese, whilst in Ghana, English and Dutch firms are the most important. In Cameroon, European firms have a wide presence: the French group Pasquet has licenses for over 300,000 hectares, the Belgian group Decolvaenere 200,000 hectares and the Italian group SEFAC over 500,000 hectares.[24] In total, these three groups control logging in more than 10 per cent of the allocated forest concessions. The Asian companies are more dominant in Equatorial Guinea, the CAR and the South Congo.[24]

In Equatorial Guinea, Shimmer International, a Malaysian group, has licenses for 500,000 hectares, out of a total forest area in the country of 1.25 million hectares. Medium-sized businesses operate alongside the multinationals, often African or European, largely focused on short or medium-term strategies (in part through a lack of technology or suitable finance).

2.2.1.2 Future trends

Although publicly available statistics on the configuration of the corporate landscape in forestry is sparse, extensive consultations for this report indicate that in the Congo Basin and perhaps in much of tropical Africa, the introduction of new and more stringent regulations (backed by the World Bank and the IMF since the mid 1990s) has triggered structural change within the sector. The two emerging trends are increasing concentration of the export-oriented segment in the hands of large companies (usually foreign-owned) where trades are biggest, and an increasing fragmentation (or informalisation) amongst smaller companies generally executing smaller trades, at the bottom end of the market. The implications are unclear, but may presage greater difficulty in regulatory enforcement in relation to smaller companies.

In supply terms, the future trends for industrial logging in tropical Africa are unclear. While demand is forecast to rise, increasing regulation, export limitations and growing EU consumer sensitivity to environmental factors could all play a part in slowing the activation rate of currently dormant logging concessions on the supply side. Attitudes and policies relating to REDD could clearly have a major impact in this context. Capacity issues are also likely to play a part in constraining supply, because of the need for significant investment in infrastructure (transportation and communications, wood-processing plants) if output is to be increased.

Looking at future trends on the demand side, the industry is almost entirely export-orientated and is heavily dependent on the EU and Asia, with Chinese demand likely to continue growing. In Europe, the dominant trends are a steady increase in demand for processed goods and a small relative reduction in the overall demand for African raw logs. It is possible that both will continue if environmental awareness and sensitivity continues and efforts to remove illegally sourced timber from Africa-Europe supply chains, such as through the EU's Forest Law Enforcement, Governance and Trade (FLEGT) programme, are successful. Meeting raw log demand from China and other Asian countries is dependent on the willingness of individual countries to export such low value items.

2.2.2 Small-scale logging

The foreign-owned timber companies in Central and West Africa focus on extracting high value timber trees and exporting to overseas markets. Domestic demand for timber is therefore largely met by small-scale logging operating outside the concessions system. The different parts of the sector are linked, with logging companies often outsourcing aspects of their operations to informal loggers.

Only a small part of the small-scale logging sector is 'formalised' in forestry policies. In some countries, forestry codes allow for people or small companies to obtain permits to harvest small volumes of timber over specified time frames or areas. In Cameroon, nationals can obtain permits, generally for one year, to harvest up to 500 cubic metres of timber (about 300 tonnes) from a limited area of forest. Personal logging permits (for firewood, wood crafts, and home construction) can also be obtained for three months on a renewable basis, for up to 30 cubic metres of timber (about 18 tonnes).

In Tanzania, there is no system of awarding concessions, and small-scale logging companies produce most of the legal output: nationals can apply for permits to harvest a set volume of timber, but according to consultations in Tanzania, restrictions on where logging takes place seem to be limited.[25] As might be expected, permitting systems appear to cover only a small part of all small-scale logging activity and much of it remains informal or even illegal. This means that most of the output of small-scale logging goes unrecorded, and data on the scale of the sector is very poor (see below).

2.2.2.1 Community forestry

Another growing force in the small-scale logging sector is community forestry. Many different models of community forestry are practiced across tropical Africa but they all entail devolving management and/or ownership rights over forests to the community level. Indigenous peoples and other communities have managed forests under their customary ownership to procure all sorts of products – including timber but also woodfuels, medicines, tools, bushmeat and other foods – for thousands of years. Community forestry emerged in the past few decades as a way of formalising and achieving legal recognition for these customary systems of forest management.

Community forestry is promoted by NGOs, development agencies and national governments, in some cases as an alternative form of forest management to industrial timber concessions, and in others as a way of improving the regulation of the small-scale sector. It is meant to reduce the impact of logging activity on tropical forests, while protecting local communities' rights and delivering greater benefits to livelihoods. We therefore discuss community forestry in the **Interventions** section of this chapter.

2.2.3 Informal and illegal logging

The vast majority of logging in Africa's tropical forests takes place outside the rule of law or formal concessions or permit-based systems. The distinction between informal and illegal logging is blurred, and largely dependent on a country's laws.

Informal logging is often used to refer to small-scale logging activity that is not formally organised or regulated by law. This could include people living in rural areas collecting wooden poles for house construction as and when they need it, or pit sawing – a basic method of processing sawnwood in which a log is laid over a pit dug in the ground and cut with a handsaw or chainsaw.

Because informal logging is, by definition, unorganised and poorly regulated, and also includes production for subsistence purposes, regional data on the volume of timber produced is very poor. Countries do not report informal harvests to the FAO.[26] Estimates for the DRC suggest that the output of the informal sector far outweighs that of timber concessions: one report estimates that timber companies harvested 180,000 tonnes of timber in 2005,[22] while small-scale loggers harvest between 900,000 and 1.4 million tonnes every year.[27] Once processed, the authors estimate that this represents around 300,000 tonnes of sawnwood.[22]

Small, informal logging operations are responsible for meeting domestic timber demand, and account for the vast majority of total timber production in tropical African countries.

Courtesy of Global Witness

Illegal logging encompasses a broad range of activities (see Box 2), and is relevant to both industrial and small-scale logging. Unlike informal logging, illegal logging activity is not simply unregulated, but in direct conflict with regulation. Logging companies can break the rules outlined in their concessions, bribe officials, or neglect legal obligations to local communities; at the small-scale, most logging activity may be deemed illegal in some countries.

As with informal logging, the volume of wood harvested illegally is poorly recorded, and statistics are unreliable. Over 50 per cent of all timber production is attributable to illegal logging in some African countries, according to some estimates (see Table 2). Similar trends are observed in other countries: a study in the southern coastal forests of Tanzania estimated that up to 96 per cent of 11,000 tonnes harvested over a two-month period in 2004 were illegally logged, at a loss of almost $10 million in tax revenues. The same study extrapolated the figures across the entire country and estimated that the Tanzanian government lost tax revenues from timber harvest for that year of $24–$58 million.[25]

Box 2: What is illegal logging?

Illegal logging may refer to a broad range of activities, including the following:[28]

- Violations of indigenous peoples' rights, or public or private ownership rights: for example, illegally acquiring a concession through bribes or force.
- Violations of forest management regulations or contractual agreements: for example, exceeding harvest quotas, logging prohibited species, or logging outside the agreed concession area.
- Violations of regulations related to processing or trade: for example, sawmills using illegally harvested logs, or trade in prohibited species or products – many countries ban the export of raw logs to encourage domestic processing, which adds values to exported products.
- Violations of financial, accounting or tax regulations: for example, evading taxes related to the harvest and trade of timber.

Table 2 is based on figures cited in reports by the World Bank and the OECD, but some authors have questioned the accuracy of such figures, citing problems with sourcing, and a lack of clarity in the distinction between illegal and informal logging.[24, 29]

The prevailing image of illegal logging in the tropics may be of a convoy of old, rusted trucks lumbering along muddy tracks through the dense forest, with freshly cut logs piled high on the back. In reality, however, a large proportion of the wood that is harvested illegally in tropical African countries is likely to be carried out by individuals with handsaws. While there does appear to be strong consensus that the formal timber sector is far outweighed, in terms of total output, by the informal (and illegal) timber sector, statistics on the scale of illegal logging do not help illuminate which of these images is closer to the truth.

Rosewood logs lie on a riverbank in Madagascar awaiting transportation. Madagascan Rosewood is highly prized around the world for its colour and quality finish, especially by guitar makers, but is under threat from illegal logging.
Courtesy of Global Witness

African governments, and the governments of importer countries, have made several attempts to formalise small-scale logging activity and halt illegal logging through forestry policy. As mentioned above, one strategy to formalise small-scale logging that is being pursued in several tropical African countries is community forestry, often with strong support from international and national NGOs, as well as development agencies. Cameroon, Kenya, Malawi, Mozambique, Namibia, Tanzania, Uganda and Zambia have all enacted policies that devolve ownership and/or management rights to the community level, to varying degrees.[32] Community forestry policies appear to be less prevalent in Central and West African countries: the Central African Republic, Ivory Coast and Republic of Congo do not appear to have community forestry policies. See the **Interventions** section in this chapter for a full discussion of community forestry.

Table 2: Scale of illegal logging in selected African countries

Country	Per cent of total production
Benin	80%
Cameroon	50%
Gabon	70%
Ghana	60% ('at least 66%' in one report)
Mozambique	50–70%

Source: Adapted from Contreras-Hermosilla, A., R. Doornbosch, and M. Lodge, *The economics of illegal logging and associated trade*. 2007, OECD;[30] and World Bank, *Strengthening Forest Law Enforcement and Governance: Addressing a Systematic Constraint to Sustainable Development*. 2006, World Bank: Washington, DC, USA.[31]

Illegal logging is also tackled through international programmes such as the Forest Law Enforcement, Governance and Trade (FLEGT) initiative. Designed to reduce the level of EU imports of illegal wood (currently estimated at 20 per cent of total wood imports), this programme has, so far, partnered only with Ghana and Republic of Congo. There are additional examples of international cooperation but these are not always solely focused on illegal logging. Gabon, for example, has consistently adhered to the International Tropical Timber Agreement, Uganda (amongst others) is a member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), while the DRC has signed up to a number of different international agreements.

2.2.4 Forest zoning and the forestry sector

Many countries in tropical Africa have forest zoning as a key element of their forestry codes. Forest zoning involves demarcating a country's entire forest area according to different uses and legal status. Forest zoning is therefore an important factor in determining which types of forestry are active where.

Forestry codes commonly split forests into two overarching categories: 'permanent forest', owned by government (whether state, regional or local), and 'non-permanent forests', which may be owned by government, private individuals/companies, local communities, or have no legally recognised owner (see Table 3). Permanent forests are generally designated for protection (national parks, game reserves and water catchments) or production (timber primarily). Non-permanent forests may be managed for a variety of purposes – producing woodfuels, plantations, agriculture, community forestry – and regulations to ensure sustainable levels of use are usually poorly enforced.

Industrial logging is largely based in government-owned forests; small-scale logging may be in either, depending on the particular national forest code; and informal logging largely occurs in open access forests.

Table 3: Forest zoning in selected countries

	Cameroon	DRC	Tanzania	Uganda
Total forest area (ha)	21,245,000	133,610,000	35,257,000	3,627,000
Permanent forest	Permanent Forest Domain	No forest zoning - state maintains ownership of 100% of the land	Reserved forests	Permanent Forest Estate
Non-permanent forest	Non-Permanent Forest Domain		Public forests	Forests on private and customary land
Percentage of forest owned by state	77%	100%	39%	52%

Sources: Food and Agricultural Organization (FAO), *Global Forest Resources Assessment 2005*.[26]; Republic of Uganda, *Facts and Figures: Participatory Forest Management in Tanzania*;[33] WWF. *Sustainable forest management in Southeast Cameroon*.[34]

2.3 Africa and the global timber trade

Both globally and on a local scale, the timber industry in tropical Africa is significantly less valuable than the extractive industries. In 2006, global exports of timber products only amounted to approximately $200 billion, of which Africa accounts for only 2 per cent or $4 billion in total.[35] This is small when compared to the often multibillion dollar projects that the extractive industries bring to the continent. The Democratic Republic of Congo (DRC) alone has received over $5 billion in investment from China in return for mineral rights.[36] Finance on this scale makes it clear that the formal forestry sector, in economic terms, is a poor relation.

Not only is Africa's share of the global wood products trade small but also it is largely geared to the production of low value items. In 2005, Africa produced 43 million tonnes of industrial roundwood, 5.4 million tonnes of sawnwood but only 3.6 million tonnes of more processed products such as paper.[35] For comparison, Asia produced 164 million tonnes of industrial roundwood, 43 million tonnes of sawnwood and over 120 million tonnes of processed products.[iii,35]

iii Volumes of timber products are often expressed in cubic metres. We have converted all figures into tonnes assuming a wood density of 0.6 tonnes per cubic metre.

Therefore, while Africa has some 8.4 per cent of the global value of roundwood exports, the region accounts for only 0.6 per cent of the global value of paper exports (see Table 4). And it is the processed products which generate the most value added within the forestry sector: for example, of the $119 billion gross value added to Asian economies by the forestry industry in 2006, $86 billion (or 72 per cent) was from processed products.[35]

Given the overall data, it is unsurprising therefore that logging concessions produce only modest direct revenues for individual countries (see Table 5). Government revenues from timber concessions are little more than $10 million per annum in Liberia, Ghana, Central African Republic (CAR) and Equatorial Guinea. Cameroon and Gabon earn approximately $40 million and $50 million per annum respectively but this is still only a fraction of the total GDP and very insignificant when compared to revenues from oil and mining. In Cameroon, for example, oil revenues have been estimated at $480 million per annum – over 10 times the value of revenues from the industrial forestry sector. In the more oil-rich Republic of Congo, the comparison is even starker: in 2003, oil revenues were approximately $2.3 billion compared to $20 million generated from forest concessions.[24]

Table 4: Africa's share of trade in wood products

	Imports		Exports	
	As % of global value	As % of consumption in Africa	As % of global value	As % of consumption in Africa
Industrial roundwood	0.7	1	8.4	6
Sawnwood	3.3	45	3	23
Wood-based panels	1.4	45	1.9	37
Pulp for paper	0.8	26	1	36
Paper, paper board	2.5	51	0.6	12

Source: Food and Agricultural Organization (FAO), *State of the World's Forests 2009*. 2009. Available from: ftp://ftp.fao.org/docrep/fao/011/i0350e/i0350e.pdf.[35]

Table 5: Summary of the economics of forest concessions in Central Africa

	Cameroon	Gabon	Congo
Forest revenue (forest taxes)	$40m	$50m	$20m
Employment (formal sector)	13,000	11,500	6,500
Est. informal employment	150,000	Likely low	Likely low
Contribution of sector	3.1% (3.2% of non-oil GDP)	6.4% of non-oil GDP	5% (10% of non-oil GDP)
Average size of concessions (ha)	150,000 to 600,000	300,000 to 650,000	200,000 to 1.3m
Nationality of largest concessionaires	Italy, France, China	France, Italy, China	Germany, Denmark, France
	DRC	**CAR**	**Eq. Guinea**
Forest revenue (forest taxes)	$3.85m	$10m	$12–13m
Employment (formal sector)	15,000	4,000	2,000
Est. informal employment	Likely high	Likely low	N/A
Contribution of sector	N/A	N/A	N/A
Average size of concessions (ha)	300,000 to 1.8m	180,000 to 700,000	550,000
Nationality of largest concessionaires	Germany, Lebanon, Belgium	China, Lebanon, France	Malaysia
	Ivory Coast	**Ghana**	**Liberia**
Forest revenue (forest taxes)	$15.7m	$13–15m	$13m
Employment (formal sector)	25,000	8,000	8,000
Est. informal employment	Likely high	Likely very high	N/A
Contribution of sector	N/A	N/A	N/A
Average size of concessions (ha)	150,000 to 500,000	15,000 to 140,000	N/A
Nationality of largest concessionaires	Lebanon, Italy, France	UK, Germany, Netherlands	Malaysia

Source: Karsenty, A., *Overview of Industrial Forest Concessions and Concession-based Industry in Central and West Africa and Considerations of Alternatives*. 2007, CIRAD.[24]

These numbers, however, underestimate the economic importance of forestry if employment and other factors are taken into consideration. First, these are direct revenues and ignore the total value added by the sector. The Ghanaian government, for example, estimates that total export earnings in 2007 were $180 million and cites the industry as a critical source of foreign exchange.[37] In Uganda, a country not noted for its large forestry industry, the sector was calculated to account for some 6 per cent of GDP in 2001.[38] In addition, direct employment figures can be significant and account for as much as 29 per cent of the regional workforce in Congo Basin countries.[39] In Ghana, the forestry sector is estimated to employ some 50,000 people but the numbers are much lower in most other countries, with only 13,000 and 11,500 employed in Cameroon and Gabon for example.[24]

Direct revenue estimates also ignore the informal sector and jobs associated with wood products such as furniture making or wood carving. In Ghana, for example, tertiary employment is estimated at around 55,000 and for Cameroon, the informal or illegal sector could include up to 150,000 workers.[24] Forestry may not be as critical to Africa's economy as the extractive industries but it is still an important source of employment and foreign capital.

Another factor is that while the forestry sector may be much less important than mineral and energy extraction at the national level in tropical African countries, it can be critical to isolated local economies. Taken as a whole, the forestry sector provides many jobs (usually non-skilled) in often remote and economically marginalised areas. The result is that millions of Africans depend on forestry, in all its guises, for support and survival. It is important again to note the lack of reliable data on the illegal and informal sectors, which, given their dominance in the supply of forest products, further undermines the usefulness of statistics which describe only the formal industrial sector.

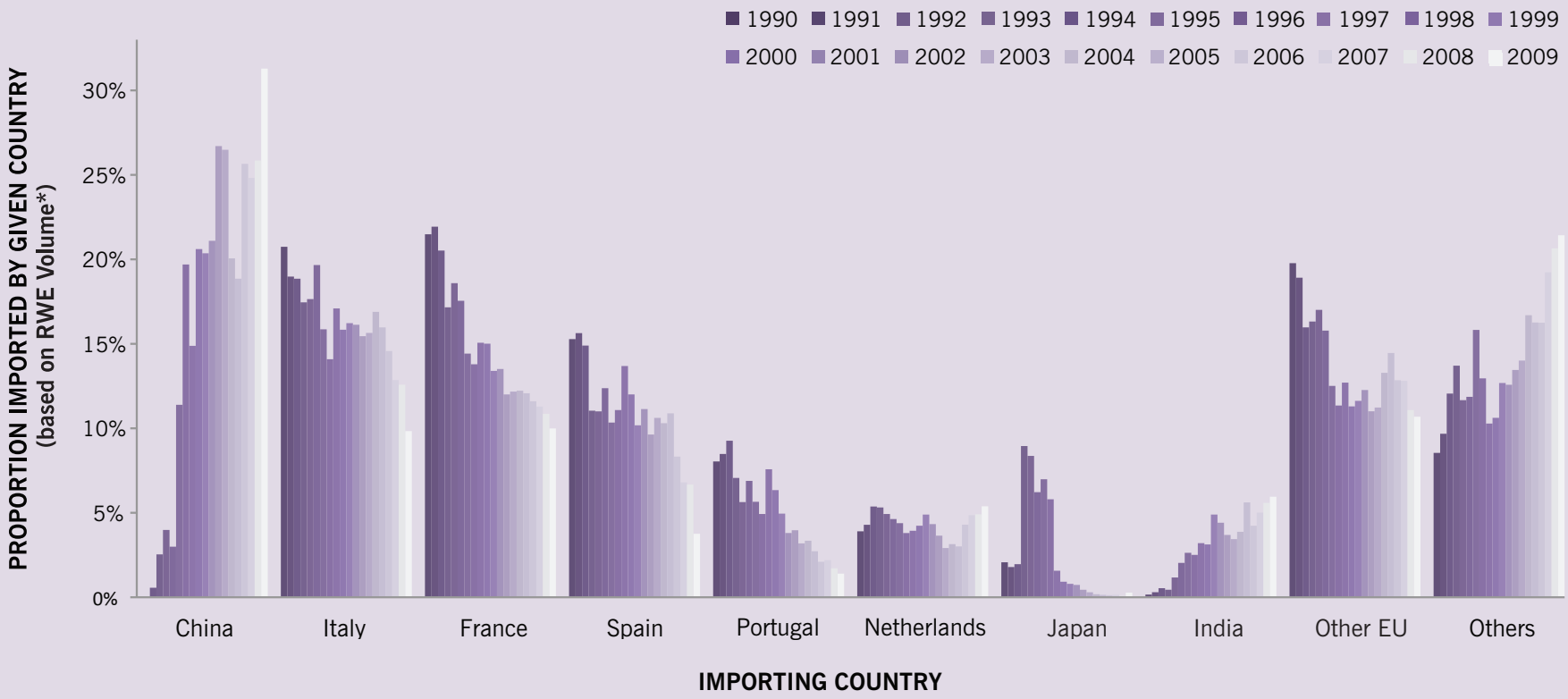
Since the start of the colonial era the timber trade in Africa has relied on European demand, and the EU remains the major market for West and Central African wood exports. But since 1995, EU demand has slackened, due to a combination of increasing domestic environmental sensitivity and decreased price competitiveness from African products. France, for example, used to account for approximately 17 per cent and 35 per cent of annual demand for roundwood in Cameroon and Gabon respectively, but trade has slipped to 7 per cent and 25 per cent respectively, as French consumers react to environmental concerns.[40] Yet, as traditional ties with Europe weaken, China's rapid growth is providing a growing market for African wood: in 1995, China accounted for less than 5 per cent of African timber exports, but by 2004 this figure had risen to over 30 per cent.[40]

Europe remains, however, the major market for African wood: in 2006, the EU imported about 2.6 million tonnes of RWE (roundwood equivalent) compared to 1.3 million tonnes exported to China.[41] And although Chinese demand for African wood has grown considerably, it has risen less rapidly than China's overall demand for timber imports. Africa's share of total Chinese wood imports actually declined from 4 per cent in 2000 to less than 3 per cent in 2006.[41] In other words, the rise in demand for African wood is a small part of a huge growth in Chinese demand for world timber as opposed to a particular emphasis on African timber.

The overall figures mask considerable variation on a country-by-country basis: in the west of Africa the more established producers, such as Ghana, the Ivory Coast, Nigeria and Cameroon, export largely to the EU with little Chinese trade; but, conversely, Chinese imports account for 90 per cent of Mozambique's exports, 70 per cent in Equatorial Guinea, 50 per cent in the Republic of Congo and 40 per cent in Gabon.[41]

In addition to sourcing differences, China and the EU focus on very different products. China imports almost entirely logs from Africa (85 per cent by volume in 2006) – ie, raw, unprocessed products.[41]

Figure 1: Main export markets for West and Central African timber



Source: Globaltimber.org.uk.[11]

This is because China's manufacturing efficiency and cheap labour can overcome the high prices and transportation costs of logs: a product of China's economic structure and Africa's willingness to export such low value products. In Europe, however, demand for processed products from Africa is growing: in Gabon, 60 per cent of exports to the EU are processed goods and similar trends can be seen in Ghana and Cameroon.[41]

These trends appear to reflect two interdependent factors: Europe's sensitivity to environmental concerns and different national forestry policies in tropical African countries. Gabon, Cameroon and Ghana have implemented log export bans, which has seen trade with China wane.[42] Currently, therefore, Africa's traditional ties with the EU, combined with increased concern for environmental services, perhaps creates an opportunity for increased regulation, higher value products and a focus on conservation. However, China's demand for unprocessed logs, combined with Africa's willingness to provide them, does perhaps pose a threat to this opportunity: continuing to export logs will keep the African forest sector undeveloped (so domestic demand can still not be met by efficient means).[41]

3. Logging impacts, problems and challenges

In this section we look at the impacts of industrial, illegal and informal logging across tropical Africa, and assess the threats that they pose. For analysis of selective logging and plantations, see the **Interventions** section.

3.1 Industrial logging

As we saw earlier in this chapter, the current emissions from logging in Central tropical Africa are dwarfed by the potential carbon losses that could be generated if the 133 million hectares of production forests in six countries were to be logged. Logging this area of forest under current logging intensities for industrial logging concessions in Africa (1–5 trees per hectare) could release 5GtCO_2, but if this were to rise to logging intensities in South-East Asia (8–15 trees per hectare) it could reach over 50GtCO_2 – equivalent to double global emissions in 2005.[18-20] This calculation does not include currently unlogged production forests in West and East Africa, and is thus an underestimate for the whole of tropical Africa. It also does not include very large areas of forest that are under governmental control, which could be designated for logging.

Yet despite the scale of this threat, data on emissions from logging in the region are limited, in part because land carbon measurement in tropical African countries is in its infancy, and in part because only a small number of peer-reviewed ground-based studies have been carried out, with a particular dearth of comparative analysis on the impacts of different logging and other forestry practices. The measurement of logging impacts is further complicated by difficulties in assessing indirect as well as direct consequences, such as increased vulnerability to fire and increased conversion of forests to agriculture in already logged forests. But while the data deficiencies do constrain precise analysis of particular forests and regions, the fundamentals of logging impacts are clearly understood.

3.1.1 Direct impacts

Courtesy of Global Witness

- Where clear felling is practised, almost all aboveground biomass carbon is likely to be removed.
- Selective logging can lead to substantial loss of forest carbon. The amount of carbon lost varies according to logging intensity, which in the tropics is often reported to be highest in South-East Asian forests (Malaysia and Indonesia), and lower in South America and Central and West Africa. Studies have found that selective logging in South America and Africa can result in the loss of 5–20 per cent of carbon stocks, but can be as high as 50 per cent in South-East Asia.[3, 18, 19]
- Collateral damage to the surrounding forests as targeted trees are felled and extracted can be substantial. The amount of carbon lost is not simply reducible to the amount of wood taken out. Many unlogged trees are severely damaged as a by-product of selective logging operations, leading to forest degradation.
- Many forests under timber concessions are logged too frequently for forests to recover adequately. This means that an area of forest is logged again too quickly for it to be sustainable.[43] In terms of carbon, short rotations could prevent a forest from returning to levels of carbon storage found in mature forests, because the approach focuses on removing the largest trees which store the most carbon (but take the longest to grow).
- Recent studies have confirmed that tropical forests continue to sequester carbon from the atmosphere once they reach maturity (it was previously believed that old growth forests were 'carbon neutral'), which means that logging results in the loss of a long-term carbon sink.[44-46]

3.1.2 Indirect impacts

Industrial and selective logging triggers indirect consequences that weaken forest resilience, making it more likely that further carbon losses will occur after the first cut has taken place:

- roads built during the first cut phase usually become permanent, leading to easier access for illegal and informal loggers and farmers, in turn leading to additional logging and conversion of forests to agriculture;[47]
- the loss of the canopy can increase the vulnerability of forests to fire and drought;
- forest dieback – many trees are adapted to dense forest conditions, and do not survive the exposure to wind, sunlight and water loss that forest thinning can trigger; and
- logging damages the ecological richness of forests, leading to reductions in seed dispersal and germination that can adversely impact forest resilience and carbon storage intensities.

3.1.3 The evidence base on logging impacts

Below we summarise what is known on the range of carbon losses and gains that can occur in logged forests. Because of the dearth of Africa-specific studies, some of the current benchmark articles are based on studies carried out elsewhere in the tropics.[iv] The overall conclusion is that while further research is needed to narrow some of the very wide data ranges, the underlying implications are clear: logging is overwhelmingly negative in carbon terms.

Asner.[49, 50] Researchers at Stanford University's Carnegie Institute carried out the first large-scale assessment of logging in the Brazilian Amazon based on high-resolution satellite imagery and new analytical techniques capable of detecting small forest canopy openings. A number of striking observations were made:

- the area of forest being degraded by selective logging was roughly equal to the area deforested over the same period;
- the level of degradation was high – 76 per cent of the canopy damage was severe enough to leave the forest susceptible to drought and fire; and
- on average, one third of the forest area that was selectively logged in the year 2000 was completely deforested by 2004.

One of the studies also found that in areas with high population pressures, such as the eastern fringes of the tropical forests of the Amazon, logging exposes the forests to the risk of permanent conversion to agriculture and associated settlements.[50]

Brown.[18] The Global Witness report comments on a study by Sandra Brown for USAID on a concession run by Congolaise Industrielle des Bois (CIB) in the north of the Republic of Congo, which *'is sometimes alluded to as a model of "sustainable forest management". But even here, in the course of harvesting 120 trees, another 727 trees were severely damaged (stems snapped or uprooted) and left to decompose, resulting in half a tonne of carbon in collateral damage created per cubic metre of commercial timber extracted*.'[48] The carbon loss from skid trails in this operation was determined to be 6.8kg per metre of trail, or 0.09 tonnes per hectare, while roads generated 2.6 tonnes per hectare. Overall, the study found that the total carbon lost from the forest resulting from this 'reduced impact' logging was 10.2 tonnes per hectare (including extracted biomass carbon and damaged biomass carbon in logging gaps, skid trails, and logging roads).

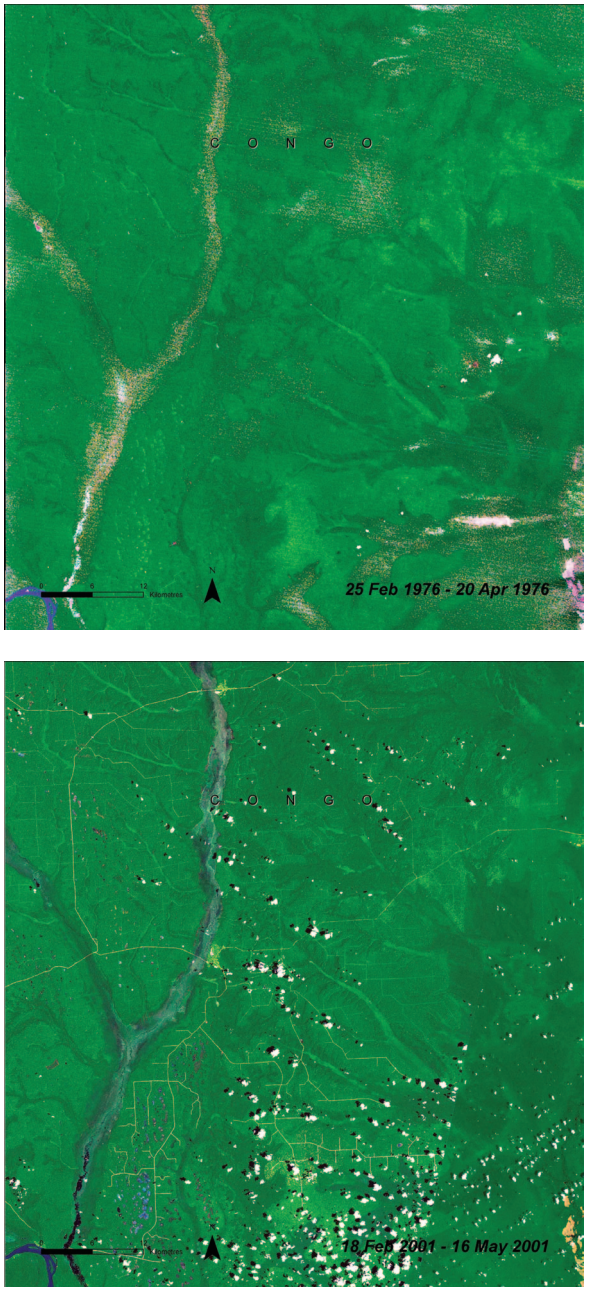
FAO. A 1999 study found that, due in large part to the access provided by roads, the deforestation rate due to conversion to agricultural land was eight times higher, overall, in forests that have been logged than in undisturbed forests.[51] The Congo Basin has over 50,000km of logging roads; Gabon alone has a network of 13,400km of logging roads – more than the length of the German autobahn network.[52]

iv Principal secondary sources drawn on for this section include the **ProForest** report and the Global Witness study, *Vested Interests: Industrial logging and carbon in tropical forests*.[48] and many of the papers referenced in these reports.

Feldpausch.[19] An assessment of a logging operation certified by the Forest Stewardship Council (FSC) in the southern Amazon employing RIL found that collateral damage released twice as much carbon as the harvest of target trees. While on average only 1 or 2 trees were harvested per hectare, 10 trees were severely damaged in the felling of each target tree, and 6 trees per hectare were destroyed in the construction of log decks and roads within the same area. Overall, logging damage produced 4.9–8.8 tonnes of carbon per hectare, contained in coarse woody debris. This was over twice the amount removed as logs (2.1–3.7 tonnes of carbon per hectare).

International Tropical Timber Organization (ITTO). A 2007 study report on the forests of Papua New Guinea (PNG) noted that nearly half of the trees in a typical 'selective' logging operation are killed. Only 5-6 per cent of the total wood volume is removed as timber – most of the rest ends up as greenhouse gases in the atmosphere. An estimated 20.5–23.2 million tonnes of carbon were released in 2007 as a result of logging-related deforestation and forest degradation. By comparison, the largest coal-fired power plant in the United States released 7.4 million tonnes of carbon in the same year. The study estimates that if carbon were assigned a nominal value of $10 per tonne of CO_2, the annual emissions from logging operations in PNG would be worth more than the total value of forestry exports, which averaged $156 million annually in recent years.[53]

Lewis,[44] ***and others***. A 2009 paper, based on forty years of study in Africa, found that primary tropical forests continue to grow and sequester carbon. Other evidence on the sequestration properties of mature forests includes a 2008 survey of forest carbon-flux estimates which found that primary forests older than 200 years sequester on average 2.4 tonnes of carbon per hectare per year, with much of that contained in soil and root organic matter,[45] and a 2004 study of the total biomass of Amazonian old growth forests, which found that it had increased by as much as 1.22 tonnes per hectare per year over the past two decades.[46]



The above satellite image show the penetration of logging roads into the rainforest of the Republic of Congo over a 25-year period between 1976 and 2001. Logging roads can be a catalyst for deforestation as previously remote areas of forest are exposed to new activities.

Courtesy of UNEP

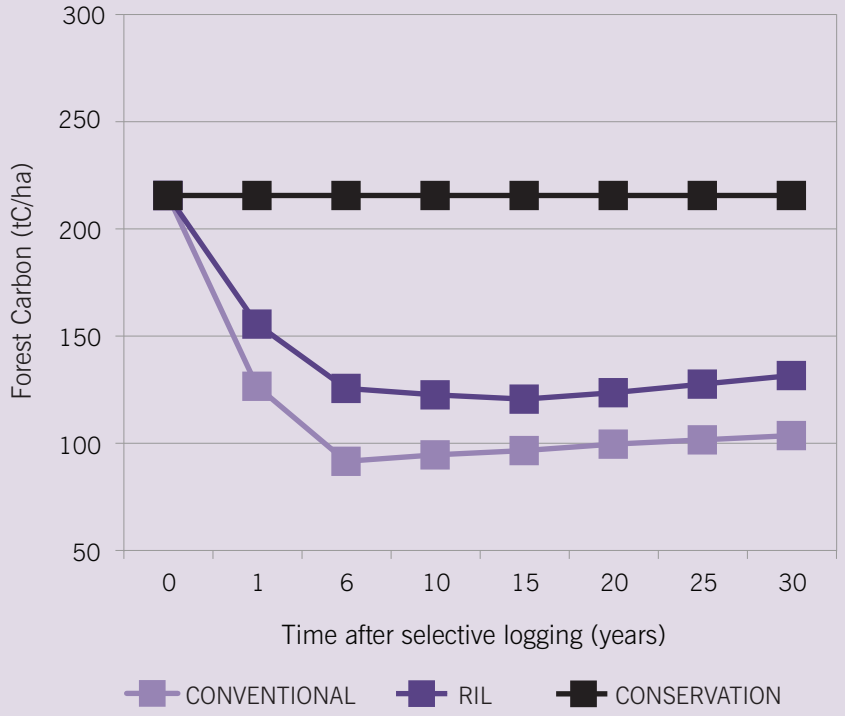
Pinard and Putz. A study in Sabah, Malaysia, found that reduced impact logging (RIL) destroyed 15 per cent of large non-target trees compared to 41 per cent in conventional selective logging operations; one year after logging, RIL sites were found to retain 67 per cent of the original biomass, compared to 44 per cent for the conventionally logged sites.[54] Another study, which drew on data from Sabah, Malaysia and Para, Brazil, found that applying RIL techniques reduced emissions from logging by almost 30 per cent.[20]

But as the Global Witness report notes, *'comparisons of emissions from RIL with a business as usual scenario of conventional selective logging are misleading. These comparisons hide the substantial damage that RIL causes to forests relative to their undisturbed state.'* The dotted black line in Figure 2 represents the forest carbon stocks that would be retained in the forest if it were kept fully intact, rather than logged. At 30 years after logging, the forest logged using RIL techniques has approximately 30 tonnes more carbon per hectare compared to the site of conventional logging. Compared to the forest under conservation, however, RIL has still resulted in the loss of about 78 tonnes of carbon – over a third of its total.[48]

Redford, Corlett. In regions with lower population density, such as parts of the Congo Basin, new roads provide greater access leading to unregulated logging and poaching activity in remote areas that are difficult to control. As a result, wildlife becomes more vulnerable to exploitation for the commercial trade in bushmeat. The loss of these forest-associated species leads to 'empty forest syndrome', whereby the absence of animal vectors results in the failure of a surprisingly large number of plant seed dispersal and germination processes, further impoverishing the forest and its ecological resilience.[56, 57]

Uhl, and others. Intact tropical rainforests are virtually immune to fire,[58] but as these forests are degraded by human activities the frequency and extent of fires increase.[59] In particular, degradation due to industrial logging is one of the major causes of increased fire susceptibility in tropical forests.[60] The canopy gaps caused by logging disrupt the cool, moist microclimate underneath the canopy. Exposure to sun and wind dries out vegetation and increases the likelihood of fire.[61] In addition, collateral damage from logging leaves behind dead and dying debris that, once dried, can serve as fuel for fires. The combined effect is an increase in the flammability of the forest. Openings in selectively logged forests in the eastern Amazon were found to burn after 5–6 rainless days and in secondary growth forests after 8–10 days.[58]

Figure 2: Carbon stocks in forests recovering from conventional selective logging and reduced impact logging in Sabah, Malaysia



Source: Adapted from Global Witness, *Vested Interests: Industrial logging and carbon in tropical forests*. 2009. Available from: www.globalwitness.org.[48] Originally adapted from Putz, F.E., et al. *Improved Tropical Forest Management for Carbon Retention*.[55]

3.1.4 Industrial logging as a bulwark against expansion of agriculture and biofuels?

Industrial logging is a prominent land use in the forests of Central Africa, with more than 40 million hectares under active and dormant logging concessions – 22 per cent of the forest area, compared to the 15 per cent of forests in protected areas.[10] It is also significant in West Africa. In East Africa, industrial logging is more limited, partly as a consequence of economic difficulties over the last two decades, but also as a function of lower value timber trees in the region.

A seemingly counterintuitive argument proposed by some experts is that far from being curbed or halted, industrial logging should be maintained as an effective carbon and forest ecosystem protection strategy: *'Timber production, if properly managed, can maintain most forest carbon stocks and offset opportunity costs of slowing the expansion of palm oil and swidden agriculture.'*[62]

Part of the rationale for this defence of industrial logging is a fear that a 'land use vacuum' could arise in the event that logging concessions are cancelled. The forests in question might have uncertain status within national forest zoning plans, or they could simply revert to common public lands, open to informal logging and vulnerable to disputes and confusion over land tenure. 'De-regulated concessions' could also open the door for something worse than removal of timber through logging: the full or partial conversion of forests for food and biofuels production. The pressure to convert Africa's tropical forests into agricultural land over the next few decades to meet growing domestic and global demand is likely to be very significant (see the **Agriculture** chapter).

3.2 Illegal and informal logging

Illegal logging is a clear problem in tropical Africa and this is widely acknowledged. Indeed, there are a number of domestic and international initiatives to address this issue. Many countries, for example, have tried to improve their forest management policies with the aim of producing greater restrictions on timber harvests. At the same time, there seems a lack of willingness to address a fundamental issue: if over 80 per cent of all wood extracted in Africa is for wood energy purposes (see the **Woodfuels** chapter) and the remainder is for roundwood,[26] and over 50 per cent of total wood extractions are deemed illegal in many tropical African countries (see Table 2), what is the overlap between the two sets of data estimates?

The conclusion is inescapable: most supposedly 'illegal' wood extraction is really a form of informal logging, carried out by millions as a basic survival strategy. Following this logic, it may be the case that initiatives such as FLEGT have only marginal significance in tropical Africa, compared with the pressing need to meet domestic demand for timber and woodfuels in ways that do not cause deforestation and degradation.

4. Interventions and responses

This is a challenging area for donors and funders, because the goal of forestry is the extraction of resources – the opposite of forest conservation. The assessment of whether or not to provide support is therefore focused on the extent to which relative carbon gains can be obtained through activities that limit harm. We also explore the responses of key organisations to the activities of the forestry sector, for example the opposition of Global Witness and the Ecosystem Climate Alliance to industrial and selective logging.[63] The material is organised under four headings:

- **industrial logging** – limiting the negative impacts through Sustainable Forest Management (SFM) and other approaches;
- **plantations** – options for meeting domestic timber needs in tropical African countries using the plantation model;
- **community forestry** – an overview of the options and issues, including examples from Tanzania and Cameroon; and
- **conservation concessions** – some initial calculations on the requirements for converting forestry concessions to conservation areas.

4.1 Industrial logging

Interventions on industrial and selective logging fall into three groups: lobbying and campaigning to curb, constrain or stop logging activity; measures to reduce unnecessary logging and waste – the drive for greater operational efficiency and thus lower impact on forests; and strategies to promote and improve selective logging, forest certification schemes, and other Sustainable Forest Management (SFM) approaches.

4.1.1 Advocacy: policy work and campaigning

Several leading international forest NGOs campaign and lobby on industrial logging in tropical Africa, often producing reports as outputs. These are often invaluable contributions, highlighting damaging forestry activity that would otherwise go unnoticed.

Courtesy of Global Witness

The **Environmental Investigations Agency** has produced studies of timber flows and illegal logging relating to a number of countries across the tropics, including several in tropical Africa.[64, 65] **FERN** plays a leading role on illegal logging, especially in the context of the European Union's FLEGT programme.[66] **Forests Monitor** is focused on corporate activity in forests, including in Liberia, the DRC and the Republic of Congo.[67]

Many **Friends of the Earth** reports on forests include coverage of logging issues relating to Africa. **Global Witness** has published Vested Interests,[48] the most comprehensive report on the logging industry in the tropics. It has also played a key part in highlighting concerns on Sustainable Forest Management within the REDD process, through the **Ecosystem Climate Alliance**.[63] **Greenpeace** has produced several major reports, including *Africa's Forests: Vital for our Climate*,[68] *Carving up the Congo*,[69] and *Conning the Congo*.[70] **Rainforest Foundation UK** works on many aspects of the protection of the rights of forest peoples in tropical Africa, and has produced a range of publications, including *Forest Management Transparency, Governance and the Law: Case studies from the Congo Basin*[71] and *The Use of Non-Timber Forest Products in the Congo Basin: Constraints and Opportunities*.[72]

4.1.2 Regulation, management, and efficiency measures

Regulatory reform of the forestry sector is taking place in a number of African tropical countries, notably Liberia, the DRC and Cameroon. One aspect of reform has been the involvement of NGOs as independent monitors of industrial logging operations, as a means to address corruption and illegal logging.[22, 73] In Cameroon, Global Witness (with funding from international donors) was appointed in 2001 as an independent observer of forestry activity throughout a number of concessions. Its role includes monitoring of the allocation process and advising on the improvement of rules and criteria in the bidding process.[73] Similar projects have been adopted in the Republic of Congo and the DRC.

Another approach to strengthening regulatory control and management is the development of partnerships between NGOs and logging companies. These can broadly be seen as aspects of corporate responsibility. Issues addressed include biodiversity protection within concessions; services provided by companies to local communities; closure of logging roads after the harvest phase; and company investments in local agricultural intensification in already cultivated areas.

Some commentators suggest that donors should shift their funding support away from the development of management plans (as these should be seen as part of the corporate responsibility of logging companies) to funding of the human resources needed to provide adequate oversight, within logging companies, government, and NGOs with monitoring responsibilities.[10, 22] This call is recognition of a fundamental reality in many tropical African countries: the lack of capacity and expertise, both within governmental departments responsible for forestry sector oversight, and logging companies themselves.

Several leading NGOs and international organisations work on many of these issues in tropical Africa, including **Tropical Forest Trust**[74] and **CIFOR**.[75]

4.1.3 Sustainable Forest Management (SFM)

Sustainable Forest Management (SFM) is a term used to refer to a broad range of practices that aim to sustain a productive supply of products from forests while reducing the impact of extraction, and also improving the social and economic benefits to local communities.[9] SFM can be used to refer to many different forest uses, from logging in timber concessions to the extraction of honey, rubber, woodfuels and other products and materials. This section focuses on SFM in the logging context. In terms of practices to reduce the impact of logging on forests, SFM includes two main elements:

- **sustained timber yields (STY)** entails limiting the timber harvest to trees of a particular size, or to a number of trees (or volume of wood) per hectare; and
- **reduced impact logging (RIL)**, which encompasses a variety of techniques to reduce collateral damage to surrounding forest caused by felling and extracting trees, including minimising width and density of logging roads; cutting away vines and lianas from target trees, which can tangle the canopies of multiple trees together; controlling the direction of felling to minimise damage to other trees; and disallowing timber felling near streams or important water catchments.

SFM has been introduced into tropical African forestry in the Congo Basin as part of reforms of forest laws (Central African Republic in 1990, Cameroon in 1994, Republic of Congo in 2000, Gabon in 2001, DRC in 2002). Donor governments, like France and the UK, have played major roles in supporting the development of forest management plans that have mandated aspects of SFM throughout these countries. Progress has been patchy, particularly in those countries emerging from the years of civil war and instability. Requirements for management plans vary from one country to another, and loopholes exist in some countries that enable companies to exclude specific tree species from management plans.

SFM is now garnering much support as a strategy to reduce emissions from deforestation and degradation: tens of millions of hectares of forest in tropical Africa are currently designated for logging, as noted above, and reducing the impact of this activity on forests might help avoid substantial carbon emissions. Whether SFM should be considered a 'REDD activity', which would make it eligible to access finance on international carbon markets, is a serious point of contention between negotiating parties. Some argue that SFM can substantially reduce emissions from conventional logging; others argue that, in the absence of clear criteria about what SFM is in practice, repackaging SFM as a REDD-plus strategy could open the door to industrial logging being classed as forest conservation.[48]

What should philanthropists make of this debate? Should they consider supporting SFM projects to protect tropical forests in Africa? Our guidance is that this route is high-risk and problematic, in large part because the term is a debased coinage. Many (if not most) logging companies claim they are practising SFM, yet practices vary widely. The consequence is that almost any logging approach can be described as part of an SFM regime, leading to a risk that SFM can be used to sanction highly destructive deforestation and degradation. This puts an onus on donors and funders to acquire locally specific information, ascertaining what SFM means in practice, for a particular company in a particular concession.

4.1.3.1 Is SFM an effective forest carbon protection approach?

There is an extensive literature on SFM[3, 76-89] yet there is a dearth of data and comparative analysis on changes in forest carbon resulting from SFM practices. Overall, arguments for and against SFM in the tropical Africa context rest on a very small number of studies.[18, 43, 62]

The case for the application of SFM to timber concessions in tropical Africa has three principal elements:

- Conventional selective logging in Central African concessions may involve the removal of only 1 tree per hectare (reported to be one every 3 hectares in the DRC), meaning that degradation is minimal and forests quickly recover.[43] This argument is supported by one widely cited study which draws on field surveys in a timber concession in northern Republic of Congo, owned by the Swiss-German company Congolaise Industrielle du Bois (CIB). This found that logging in the concession resulted in the loss of 10.2 tonnes of carbon per hectare.[18]
- Some commentators argue that timber concessions can prevent the expansion of commercial cash crops, such as palm oil or sugarcane. Designating a forest for industrial logging can therefore represent a substantial saving of carbon, if the most likely alternative land use is agricultural land.[62]
- If logging in one country's forests was halted completely, loggers would simply move elsewhere, if demand for timber products remains high enough. Total net deforestation would not be reduced, just moved from one place to another, and the net effect on carbon emissions would be negligible. Proponents of logging as a potentially sustainable activity therefore argue that as logging is inevitable, the most effective approach is encouragement for logging companies to further minimise their impact on forests.

Well-enforced management plans may help reduce the carbon emissions associated with industrial logging.

Courtesy of Global Witness

Those opposing SFM focus on three issues:

- The low rate of harvest per hectare reported for timber concessions in Africa above is partly a function of poor rural infrastructure: poor transport, neglected sawmills and other processing facilities and inefficient ports push up transaction costs, which means that it is only profitable for timber companies to harvest the most valuable trees. If infrastructure improves, and the global demand for timber products increases, this could possibly change in the future.
- There are no widely agreed standards by which to judge whether or not a concession is being managed 'sustainably'. The **Ecosystem Climate Alliance** is leading NGO resistance to SFM as an allowable activity within REDD.[63] It argues that the lack of standards determining what is 'sustainable' forest management has led to the label being applied to 'business as usual' logging, quite clearly unsustainable practices in natural forests, such as clear felling and logging in primary forests.
- Logging, regardless of how it is carried out, always involves the loss of carbon – it will never be able to compete with full conservation. This almost seems like a truism – logging causes more degradation than not logging – but it is a point that is rarely made in the literature. When evaluating the impact of industrial logging on forest carbon stocks, proponents take the measurement against the baseline of total forest loss, through agricultural conversion for example. In this way logging looks favourable, but when measured against a baseline of an intact forest, logging is clearly not optimal in terms of carbon.

4.1.3.2 SFM versus conservation in the REDD-plus policy context

As originally framed, REDD sought to base rewards and penalties (or allowable and disallowable activities) on *relative* carbon gains and losses. The DRC, for example, has a low historical net rate of deforestation compared to Indonesia: 0.4 per cent compared to 1.7 per cent, respectively (for 1990–2000).[26] The low rate is in part attributable to the slowing down or cessation of large-scale forestry and agriculture sectors during the years of civil war and instability. So the change needed for the DRC to do better than its historical record is relatively small. In this context, selective logging could be a sensible strategy, because the relatively lower emissions from this approach (compared to standard industrial logging or conversion) would produce a relative carbon gain.

But while this thinking is a logical response to deforestation, it does not address the problem of forest degradation, the other 'D' in REDD. If all of the DRC's concessions (active and dormant) were to be selectively logged, then large areas of forest would be degraded, which in turn would make them more vulnerable to eventual conversion to other land uses. The argument thus comes full circle: selective logging degrades, and degradation can lead to deforestation.

The emergence of REDD-plus during 2009 was a clear indication that the dangers of relativism had been recognised. REDD-plus calls for: *'Reduced Emissions from Deforestation, forest Degradation, conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries.'*[90] The relativistic tensions are still evident, because the concept of *reducing* has continued pre-eminence. However, two positive goals have been added: *conservation and enhancement of forest stocks*. Coming back to SFM, we can see that REDD-plus sets up a potential conflict between *conservation* and *Sustainable Management of Forests*. Inherited from the Bali Action plan, 'sustainable management of forests' can be equated with SFM, within which selective logging is a guiding principle (through RIL). Some commentators argue that SFM is an essential REDD-plus component,[91] others argue against this.[63]

Despite the ongoing tensions on these issues, REDD-plus has clearly shifted the strategic focus toward forest protection, away from the initial REDD preoccupation with a reduction in utilisation. One view of REDD-plus is that it could go further still in this direction, eventually settling on a target for rebuilding forest carbon stocks in the tropics. This might mean actively increasing the total forest area, and encouraging natural regeneration at large scales.

4.1.3.3 Forest renewability, resilience, and degradation

Within the second argument – that damage limitation can morph into forest destruction – there are significant differences of view on three issues: the renewability of forests; forest resilience; and forest degradation.

One of the strongest arguments for many biodiversity conservation programmes is that we do not know how to breed animals like orang-utans, killer whales and mountain gorillas. If we reduce wild populations below critical levels, species will not be able to survive unaided and will become extinct, or non-renewable. The selective logging, certification and SFM school of thought argues that forests are different. Trees removed by selective logging can be replaced by natural regeneration, which in humid tropical conditions can be remarkably rapid. In addition, re-growth can be supplemented: almost all species of trees can be artificially grown, through a combination of nursery cultivation and planting, if conditions are right. Therefore, trees and forests are carbon neutral *renewable resources*.

The theory of selective logging in natural forests accepts that forests are whole ecosystems, not just aggregations of trees, and that complete forest clearance and subsequent conversion of the land to agriculture or biofuels does destroy a renewable resource. But at what point is renewability impaired? By opening up the forest canopy, selective logging lets in more sunlight that stimulates carbon accumulation via faster growth of trees and vegetation, but the opening up also makes the forest more vulnerable to wind and fire, and may impair water and soil retention. Other risks include increased threats to primates and other large animals from increased hunting (it is easier to track down prey in a thinned out forest), leading to less seed dispersal[57] and thus less tree diversity, which in turn weakens *forest resilience*.

Forest ecosystem science is complex, and it is hard to predict the precise impacts of selective logging in a given forest. But the argument that intact forests are the best guarantors of forest resilience is compelling, and from a climate perspective lowers the risk of loss of permanence.

The third issue in the damage limitation and forest destruction debate is around *forest degradation*. What does degradation mean, what causes it, and how widespread are its effects? Quantifiable answers to these questions are limited. There have been very few studies of degradation – yet it is widely recognised as a major challenge, perhaps as important in the climate context as deforestation. Degradation takes various forms, and is driven by a range of factors. In some forests, informal and illegal logging (especially at forest margins) is the primary cause. In tropical Africa this has led to 'shrinking forests', particularly in drier countries such as Uganda and Tanzania where forest resilience (especially regenerative capability) is more fragile than in dense, humid, moist forests. But in many forests, degradation is a function of large-scale industrial or selective logging, whether that has been carried out informally or via commercial operations.

This opens up the prospect that the legitimisation of selective logging could lead to an expansion of the forest area within which it is practised, including forests that are not currently logged, leading to an intensification of degradation. Proponents of selective logging argue that the degradation problem is overstated, because re-growth will maintain the carbon balance, and, so long as the requisite cutting cycle is observed, the balance can be maintained in perpetuity. The risk factor here is clear: can selective logging theory be successfully translated into practice?

4.2 Plantations

Tree plantations are widely expected to play a key role in climate change mitigation, for two primary reasons: by removing carbon from the atmosphere and storing it in trees (see Box 3); and by producing timber and wood energy products, thus relieving pressure on natural forests to provide these outputs. The latter is more important from the perspective of reducing emissions from deforestation and degradation caused by logging. However, in tropical Africa, the current focus of timber plantations on exports undermines their potential to reduce the damage caused by logging: as noted above, the vast majority of timber harvested from tropical Africa's forests – over 80 per cent estimated for the DRC[27] – is not for export but for domestic uses, carried out by the informal sector.

But is this approach feasible? What land resources are required, and what are the challenges? In this section, we assess the issues and include some initial calculations for plantations that could meet timber demand, using Uganda and Tanzania as examples. We also explore the potential negative impacts of plantations. For plantations that are designed to produce wood-based energy, see the **Woodfuels** chapter.

4.2.1 Introduction

Plantations can be a much more efficient way of providing timber and pulpwood than harvesting from a natural forest: the trees, often fast growing exotic species, are planted in dense rows, treated with fertilisers and pesticides, pruned and thinned to maximise straight-line growth, and felled with precision to minimise damage. Plantations can improve profits for timber companies. But this greater efficiency also means plantations could become an important part of forest conservation by reducing the pressure of timber demand on tropical forests.[v]

Timber outputs include hardwood and softwood species. Hardwoods such as teak are used for high value products such as veneer, sawnwood, sculptures, and cut pieces for furniture and fittings. Softwoods are used for sawnwood and construction, but also for pulp and paper. Many African plantations use fast growing exotic species (principally eucalyptus, acacia and pine), sometimes called 'fast woods', which can produce yields of up to 20 tonnes of timber per hectare per year (for eucalyptus, under the right growing conditions),[92] compared to around 2 tonnes per hectare per year in logged rainforest (see scenario below). Average harvesting cycles, called rotations, in plantations depend on the tree species being used and the final product. Some eucalyptus plantations produce small wooden poles (for scaffolding, small construction, low quality furniture) in as little as 3 years, but take 30 years to grow large, high quality timber for sawnwood. Pine species take 12–20 years for pulp, and up to 45 years for sawnwood.[92]

v Planting trees may help protect forests in many other ways, beyond substituting for timber supply from forests, which are covered in their respective chapters: for example, planting woodfuel plantations, to reduce the impact of fuelwood and charcoal production on forests (see **Woodfuels**); and planting trees in buffer zones around protected areas, to protect watersheds, or assist the restoration of forests (see **Conservation**).

Box 3: Which sequesters more carbon – a plantation or a forest?

Large-scale tree plantations are seen as a key strategy for drawing carbon out of the atmosphere and mitigating climate change, with carbon credits issued via the Clean Development Mechanism (CDM) for 'afforestation' and 'reforestation'. But which would sequester more carbon: planting trees over millions of hectares, or letting forests regenerate on a large scale?

IPCC syntheses of a number of studies indicate that plantations can grow faster than natural forests in the first 20 years, thus sequestering more carbon. Plantations in tropical Africa often utilise fast growing exotic (ie, non-native) species, such as pine or eucalyptus, and the trees are densely planted, fertilised, and pruned to maximise growth.

High value hardwood plantations have been an element of African tropical forestry since the 19th century, but the growth of softwoods only began on a larger scale in the 1960s, with support from multilateral and bilateral funders. Tropical softwood plantations were seen as a means to meet global demand for pulp and paper without increasing deforestation and degradation in natural forests, drawing on the competitive advantages of developing countries: relatively inexpensive land and labour costs. In the 1970s, expansion of plantations in tropical Africa faltered, because of economic and political difficulties, which triggered widespread failures in the forestry sector.[94] Plantations were neglected or abandoned in many countries, including Cameroon, Liberia, the DRC, Gabon and Kenya.[95] In their 2003 forestry outlook for Africa, FAO noted that *'the absence of industrial development has undermined the economic viability of plantations, resulting in their poor management and outright neglect.'*[23] The return of greater civil stability in a number of tropical African countries in recent years has led to renewed interest in plantations, but with a focus on stimulating private sector involvement.[94]

Table 6: Average annual carbon sequestration in aboveground biomass for forests and plantations by ecological category
(tonnes of carbon per hectare per year)

	Years	Wet	Moist, short dry season	Moist, long dry season	Dry	Mountain moist	Mountain dry
Natural forest	≤20	5	2.7	1.2	0.6	2.5	1
	>20	1.5	0.7	0.9	0.5	0.5	0.8
Eucalyptus plantation	≤20	-	10	6.3	2.8	-	-
	>20	-	12.5	-	4	-	-
Pine plantation	≤20	9	6	4	1.7	-	-
	>20	-	7.5	5.5	1.3	-	-

However, over the long term, natural forests can sequester and store much more carbon than plantations (Table 7). A major reason for this is that tree plantations are usually established to provide products in addition to carbon sequestration services, such as timber, woodchips or paper and pulp. Regenerating forests are therefore more likely to provide a more permanent carbon sink, given adequate protection.

Table 7: Average aboveground carbon stored in forests and plantations by ecological category in tropical Africa
(tonnes of carbon per hectare)

	Years	Wet	Moist, short dry season	Moist, long dry season	Dry	Mountain moist	Mountain dry
Natural forest*	Mature	160 (65–256)	130 (80–217)	62 (60–65)	36 (8–98)	146	20
Plantation, broadleaf	≤20	50	40	15	10	50	20
	>20	150	75	35	10	75	30
Plantation, pine	≤20	30	20	10	8	20	5
	>20	100	60	30	10	50	15

* Range in brackets

Note that the values in both tables are for aboveground carbon only, and do not include belowground carbon sinks (eg, soils and root systems).

Estimates on the scale of plantation forestry in Africa today vary widely, from 3 million hectares to 8 million hectares.[23, 96] In any case, Africa is a relatively minor global player in terms of plantation area: although almost half of all timber plantations, around 67 million hectares, are located in the tropics, less than 10 per cent of that is in Africa.[96] Annual planting is estimated to be slightly below 200,000 hectares (4.4 per cent of the global planting), which is concentrated outside of tropical Africa (mainly in South Africa, but also Senegal and north-west Africa). Across West and Central Africa, Ghana is the only country with a large area of plantations (around 100,000 hectares).[23] In economic and demand terms, plantation area is not necessarily the most meaningful indicator. High value timber plantations covering relatively small areas are currently (or have existed in the past) in a range of countries (teak in Ivory Coast, Nigeria, Ghana and Togo, okoumé in Gabon).

ITTO data estimates that 75 per cent of plantation timber in Africa is from 'industrial plantations', with the remainder from 'small-scale plantations', like communal woodlots for fuelwood. This is significant by comparison with Latin America and the Caribbean, where the share of industrial plantations is put at 91 per cent.[97]

4.2.2 Timber plantations and NGOs

Much of the NGO activity around plantations centres on opposition to them. **World Rainforest Movement** is one of the leading organisations in this camp, campaigning against industrial plantations in the south, and arguing for regeneration of natural forests where local communities support the idea and if they were to benefit from forest restoration.[98] **Environmental Investigations Agency** campaigns on issues around the role of large-scale commercial agriculture and biofuel plantations,[65] and illegal logging, as drivers of deforestation. Other key campaigning organisations on oil palm plantations are **Rainforest Action Network**, **Greenpeace**, and **Forest Movement Europe**.[99]

Within the NGO community, pro-plantation organisations are scarce, although this in part depends on the definitional problems rehearsed above. NGOs like **SOS Sahel** and **Farm Africa** are actively involved in tree planting programmes that sometimes use plantation approaches and techniques to provide wood energy and timber for local communities. One important initiative is **The Forests Dialogue (TFD)**, a group of individuals from across the forestry sector engaging in dialogues on sustainability issues in forestry. TFD has conducted specific dialogues on 'Intensively Managed Planted Forests' (IMPFs), but so far not in the African context.[100]

Growing cities mean growing demand for timber products to use in construction, such as this scaffolding in Yaoundé, Cameroon.

Courtesy of Thomas Sembrés

4.2.3 Timber plantations and international and national organisations

Within international institutions, the FAO has called for a stronger focus by forest networks such as the African Forest Research Network (AFORNET), the Forestry Research Network for sub-Saharan Africa (FORNESSA), as well as sub-regional networks, on meeting fuelwood and timber demands from plantations in Africa.[23] There are likely to be sharp differences in regional focus across such networks, perhaps mirroring the distribution of plantation-based carbon sequestration projects in Africa found in the Jindal review (out of 23 projects reviewed, 11 are in East Africa or Madagascar, with none in Central or West Africa).[101]

4.2.4 Timber plantations for domestic markets: a key intervention to protect forests

Plantations can produce much more wood from less land, compared to natural forests. They could therefore reduce the impact of logging on forests by providing a new, more efficient source of timber. Some initial calculations are given below on the scale of timber plantations that would be needed to meet domestic timber demand in two African countries, Uganda and Tanzania.

4.2.4.1 Uganda

Uganda's domestic demand for timber is expected to reach an estimated 600,000 tonnes a year by 2025.[102] By this time Uganda's population is projected to reach 53 million people, implying a very low (perhaps unrealistically so) per capita consumption of 11 kilograms a year (see Table 8). Uganda's forest reserves are a major site for illegal logging.[103-108] Sourcing 600,000 tonnes of timber from these forests (assuming they are humid rainforests) every year would require a forest area twice the size of Greater London (about 300,000 hectares).

Alternatively, we estimate that it would be possible to meet all of Uganda's timber demand in 2025 by establishing only 60,000 hectares of eucalyptus and pine plantations. This is only one fifth of the land area required if humid rainforests were used.

4.2.4.2 Tanzania

Tanzania has a population of 41 million people.[109] We estimate that annual timber consumption is about 20 kilograms per person, putting annual consumption for the whole country at 820,000 tonnes a year (see Table 8). Tanzania's landscape is dominated by semi-arid miombo woodlands, a fairly open type of forest that grows relatively slowly (compared to rainforest) and is not very productive for timber harvest. We estimate that it would take almost 1.6 million hectares of miombo woodland to grow 820,000 tonnes of harvestable timber every year.

Alternatively, Tanzania's entire timber demand could be met by establishing eucalyptus and pine plantations over only 80,000 hectares of land. This would reduce the area of land utilised to meet timber demand by 95 per cent and could potentially avoid the degradation of up to 1.6 million hectares of miombo woodland.

These preliminary calculations are broadly supported by some other estimates in the literature: one report claims that 90 per cent of global timber demand could be met by planting fast growing trees over the equivalent of only 5 per cent of global forested land.[110] The authors claim that '*this could free large areas of natural forest from the pressure of timber harvests. The vast majority of remaining natural forests could consequently be devoted to non-timber uses, such as wildlife protection and habitat conservation.*'[110]

Table 8: Calculating the scale of meeting domestic timber demand in Tanzania and Uganda

	Tanzania	Uganda (2025)	Unit
Population	41,048,532	53,406,000	
Per capita consumption	20	11	kilograms/year
Total annual consumption	820,970	600,000	tonnes/year
Scenario 1: How many hectares of managed forest required to meet demand?	1,563,754	295,567	hectares/year
Scenario 2: How many hectares of plantations?	80,902	59,126	hectares
Compared to area of forest required (as percentage)	5%	20%	

Some estimates of the output of current plantations suggests that the productivity of plantations would need to be greatly improved to reach these levels: the Earth Policy Institute drew on data from the FAO to estimate that plantations currently account for less than 5 per cent of global forest area, but produce only 35 per cent of annual wood harvest.[111, 112]

Country specific figures suggest that there is significant room for improvement, however, and that plantations could play a crucial role in freeing forests for conservation. In New Zealand, plantations meet 99 per cent of the national timber demand and also are the sources of a significant timber export industry.[113] In 1997 in Zambia and Zimbabwe, half of the industrial roundwood was already coming from plantations.[114] *'Rapid plantation expansion in South Africa and Zimbabwe has significantly substituted for supply from natural forests of industrial roundwood (Kanowski, 1997).'*[94]

4.2.5 Challenges

Timber plantations clearly have potential to significantly reduce pressure on forests, and contribute to reductions in carbon emissions. But they are not panaceas, and present a number of challenges alongside the opportunities.

4.2.5.1 Competition from 'free' sources

The timber produced from plantations will not automatically substitute for timber produced from forests. If informal logging is highly active and forests poorly protected, forests will probably still remain an important source of timber. Small-scale loggers are unlikely to invest in plantations when they do not have the money or land to do so, and when it is much cheaper to simply take what they need from forests. Also, consumers are unlikely to buy timber from managed plantations if they can buy timber from a natural forest at a cheaper price.

4.2.5.2 Plantations can pose threats to biodiversity and ecosystems

As noted here and in the **Woodfuels** chapter, large tree plantations can negatively affect ecosystem services and indigenous biodiversity: for example, fast growing species may need large volumes of water, which could compromise water supply for natural forests in the area; exotic species provide poor habitat for indigenous biodiversity, and could become invasive pests if not managed carefully; and fertilisers and pesticides may pollute waterways if they are not used properly. Environmental risks can be mitigated by following good practice and careful site selection.

4.2.5.3 Plantations can negatively impact forests and their communities

Some NGOs, like **World Rainforest Movement**, are highly critical of timber plantations and argue that they often replace natural forests (see Box 4).[98] Some studies suggest that this has become less common over the last 30 years, owing partly to increased environmental awareness in export markets.[95, 110, 115] Other NGOs argue that monoculture plantations in Africa have resulted in *'major problems with land alienation affecting displaced local communities, poor working conditions, destruction of biodiversity upon which the local communities depend for food, fuel and medicines, [and] reduced water availability.'*[116]

4.2.5.4 Plantations and the competition for land

Rapidly growing population levels and limited areas of arable land raise the issue of land competition: establishing timber plantations over large areas could use up short supplies of cultivable land, and undermine food security. Where possible, plantations should be established on land that is less suitable for agriculture. Another option might be to use plantation models that allow multiple outputs: for example, timber and woodfuels, or timber and food.

Models that integrate trees into agricultural land, such as agroforestry (trees on cropland) and silvopastoralism (trees on pasture) could be used to procure timber and food from the same land. Integrating trees into agricultural land can, in some cases, also boost productivity.

A large plantation outside the city of Pointe-Noire (the second largest city of the Republic of Congo, with a population of over 600,000) provides an example of how a single plantation could meet both timber and energy needs. An area of 42,000 hectares was planted in 1978 with cloned varieties of eucalyptus, suitable for the sandy former savannah land that was considered too marginal for agricultural purposes. Initially grown solely for pulpwood, the plantations now also produce electricity, telephone poles, fuelwood and charcoal, meeting almost 80 per cent of Pointe-Noire's domestic energy requirements. Local villagers are also involved in plantation protection through the tenant farming system, receiving payments from the company in return for surveillance of the plantations (see also the **Woodfuels** chapter).[94]

4.2.5.5 Plantations for domestic markets may require subsidy

Timber consumers in tropical Africa have much lower per capita incomes than consumers in the export markets where the bulk of the current production of African plantation timber is sold. As a result, some level of subsidy from donors and funders (whether through multilateral or bilateral aid, direct private or philanthropic investment, or through REDD or CDM credits) is likely to be needed to achieve profitability for domestic-oriented plantation businesses. The Sawlog Production and Grant Scheme is a government-run fund in Uganda, originally set up with funding from the EU, to encourage entrepreneurs to establish timber plantations by covering half the establishment cost of a plantation over the first two years (see Box 5). This is just one example of how grants can help the private sector to embrace timber plantations for domestic demand in developing economies.

Box 4: Is a plantation a forest?

The Food and Agriculture Organization (FAO) defines plantations as *'forests of introduced species and in some cases native species, established through planting or seedling, with few species, even spacing and/or even-aged forests.'*[112] *The watchdog NGO SinksWatch offers a contrasting perspective: 'Forestry professionals and plantation companies insist on calling plantations "planted forests", or "plantation forests". This confusion between a crop (of trees) and a forest also made its way into the Kyoto Protocol, whose definition for forests includes tree plantations...a plantation is not a forest and the only thing they have in common is that in both, trees predominate at first glance. There the similarity ends.'*[117]

Another commentator notes some environmental differences: *'Plantations are not forests. On the contrary, they result in negative impacts on soils, water, plants and wildlife. Having none of the positive environmental effects that forests have, plantations can in no way be considered as part of any country's "forest cover". Even more, they should be considered as the final blow to the forests they substitute, because they eliminate the possibility of any natural forest regeneration.'*[118]

Claiming that plantations have none of the positive environmental effects of forests is an exaggeration: tree plantations are being used in some African countries to reduce soil erosion in water catchments (which can reduce water quality in lakes and rivers), stem desertification (the southern creep of the Sahara into coastal West African countries), and, as we demonstrate in this chapter and in the **Woodfuels** chapter, plantations can provide new sources of forest products which can relieve the pressure on natural forests. Negative impacts on water resources, for example, can be mitigated to some extent by carefully choosing species and locations.

Box 5: Case study: The Sawlog Production Grant Scheme (SPGS) Uganda

For the last 35 years, the commercial forestry sector in Uganda has been moribund, with virtually no new plantings carried out. Of the 15,000 hectares of plantations established in the 1970s, less than 1,000 hectares remain. At the same time, pressures on Uganda's forests have been intense, and remain so. A recent study estimated that the country lost 92,000 hectares of forest in 2007 alone.[102] The combination of a growing economy and a high birth rate (3.4 per cent) is creating a domestic demand for timber predicted to be about 600,000 tonnes per year by 2025. Additionally, 90 per cent of Ugandans depend on wood-based materials (principally fuelwood and charcoal) for energy.

The origins of the SPGS mirror the way in which perspectives on tropical deforestation and biodiversity challenges are shifting as the linkages with timber and wood-energy demand become clearer. In the early 1990s, the European Union began a decade of support for Uganda's forests, principally to find ways to protect the country's biodiversity in protected areas, such as the Bwindi Impenetrable National Park, which is home to half of the world's remaining mountain gorillas. Acknowledging that local need for timber was one of the main drivers of deforestation in biodiversity hotspots (which are highly valued for their ecotourism revenues), the EU provided seed funding for the first phase of the SPGS in 2002, with the aim of encouraging the establishment of 'compensatory timber plantations' by the private sector.

Launched in 2004, SPGS has directly supported the creation of 10,000 hectares of plantations, mainly pines that will be harvestable on a 12–20 year rotation, for use as sawn timber and large poles. This is a significant step toward the 60,000 hectares required to meet the 2025 demand for timber noted above. SPGS provides subsidies, training and advice for private sector foresters.

Renewed donor support from the EU, and new funding from the government of Norway should enable SPGS to reach its target of establishing a further 20,000 hectares of plantations in Uganda by 2013.[119]

4.3 Community forestry

Community forestry is an approach to managing forests that invests usage and/or ownership rights in the people who live in or around forests. Members of local villages get together, often with representatives from local government and nearby businesses, to develop a management plan for their forest. This involves defining the borders of the forest, planning which activities (woodfuels collection, agriculture, grazing, conservation, etc) can be carried out, and where, and how responsibilities and benefits are shared out between stakeholders.

The word 'community' in community forestry may refer either to indigenous minorities, such as the Pygmy peoples of the Congo Basin, or other people who live around and depend on forests for their livelihood and income.[120, 121]

Many forests in Africa are owned and managed along customary lines stretching back thousands of years. In some cases, management is good; in other cases, it is bad. Community forestry, as a formalised approach to forest management, has been promoted by NGOs, development agencies and governments since the 1970s. They aim to formalise the customary ownership and management of forests and turn it into something that delivers real economic opportunities, while improving the sustainability of use. Projects often involve efforts to create commercialised supply chains of traditional forest products – such as timber, charcoal, honey from beekeeping, wood carvings, mushrooms and other forest foods, medicines and tourism – while improving the sustainability of use.

Where forestry policies allow, community forestry projects also aim to get customary claims to ownership recognised in law. The local ownership of forests is seen as crucial to sustainable use in the body of theory underlying community forestry: where people have secure ownership of a resource and feel that they have a stake in it, they will begin to use it sustainably.[122, 123] One expert consultee (referring to Tanzania) endorses this view: *'the management strategy most often used by villagers once they have a [community forest] is to do nothing: to close the area off to outsiders, to themselves too, and let it regenerate. Utilisation of the forest may resume after a number of years, once forest condition has improved.'*

4.3.1 Scale

The area of forest formally recognised with community ownership in tropical African countries is large in absolute terms, but relatively miniscule compared to the area of forest owned by governments, or within timber or mining concessions. One study found that in five Central African countries (Cameroon, Central African Republic, the DRC, Gabon, and Republic of Congo) there are at least 73 million hectares of logging or mining/energy extraction concessions on forestlands, compared to only 1.6 million hectares designated for use by communities.[124]

Community forest of Kikole village in Tanzania. The sign reads: Community Forest Reserve for Kikole; Warning: 1) Do not light fires. 2) Do not harvest any products.

Courtesy of Paul Harrison/Mpingo Conservation and Development Initiative (MCDI)

Table 9: Community forestry across selected African countries

	Cameroon	DRC	Tanzania	Uganda
Name(s)	Foresterie communautaires	Forêts des Communautés locales	Participatory Forest Management	Community forestry
Year forest code/act	1994	2002	2002	2000
Land assigned to community forestry	1.1 million ha (2008)	Not yet implemented	4.1 million ha (2008)	1 million ha (2004)
Proportion of total forest	5%		13%	28%
Communities or villages	About 400 (2008)		About 2,300 25 per cent of all villages on mainland (2008)	13,000 (2004)

Sources: Mbile, P., et al, *Alternate Tenure and Enterprise Models in Cameroon: Community Forests in the Context of Community Rights and Forest Landscapes*;[125] Hazel, R., *Connecting community forests in the DRC with international markets: some initial ideas*;[126] Forestry and Beekeeping Division, *Facts and Figures: Participatory Forest Management in Tanzania*;[33] Mukadasi, B. and L. Mulugo, *Multi-criteria assessment of community forestry program in Uganda*;[127] and Food and Agricultural Organization (FAO), *Global Forest Resources Assessment 2005*.[26]

Community forestry is practised in various forms and under various names across tropical Africa (see Table 9), but they all involve the same fundamental principle: devolving ownership and/or management rights to the community level. The figures in this table should be treated cautiously: the level of ownership and management oversight granted to communities varies widely between countries. In Tanzania some communities are given full ownership rights over forests, while in Uganda the degree of autonomy offered to communities appears to remain limited.[32] Reported figures also often include communities involved at all stages of the implementation process: for example, although there are 400 community forests across Cameroon, covering a total forest area of 1.1 million hectares, only 178 of these have registered a formal management plan and can therefore legally exploit their land.

Many countries in tropical Africa have no policies related to community forestry: the Ivory Coast, Republic of Congo, Gabon and Central African Republic are examples. Community forestry is better developed in countries in East and Southern Africa than Central and Western Africa.

4.3.2 The history of community forestry

Community forestry has its roots in the *community-based management* models of development that rose to prominence in the 1970s, through which governments, development agencies (particularly European bilateral donors), practitioners, social scientists and NGOs have sought to foster approaches that are designed to tackle rural poverty, timber and energy needs, livelihoods and land tenure, governance and rights issues. Community forestry is to some extent a reaction against models of tropical forest development that are seen as inappropriate or undesirable, either in overall terms or in specific locales and conditions.

At one end of the spectrum there is resistance to the concession-based 'franchise' model that has dominated tropical forestry for the last several decades, in which logging companies (often foreign-owned) obtain the rights (usually through a bidding process) to extract timber, minerals and oil and gas from allocations of forestland. Concessions have been widely seen as inimical to the rights and livelihoods of forest communities. At the other end of the spectrum is equally strong resistance to the protected areas system, which is similarly seen to be at the expense of community rights and livelihoods.[128]

More recently, however, community forestry practitioners have begun to look at how carbon could be incorporated into the model, both as a goal and as a potential source of revenue for local communities, through public or private sector REDD finance.

Community forestry is fundamentally an intervention designed to tackle rural poverty and livelihoods challenges, as a 2008 **Forests Monitor** report for DFID on options for developing community forestry in the DRC summarises:[129] *'The over-arching goal of a 15 year programme is to contribute to the widespread adoption of a system of community forestry appropriate to the DRC that is able to address poverty and empower rural communities to sustainably manage their own forests and revenues.'* The approach is seen as stimulating economic activity and revenues for communities across a wide range of forest products, including timber, ecosystems services, food, rubber, medicines, other non-timber forest products (NTFPs) and tourism.

Another 2008 study by the **International Institute for Environment and Development (IIED)** is consistent with this perspective, in a review of small-scale forest enterprises, an intervention that is often a component within community forestry projects. It focuses on policy changes and capacity building initiatives that could best help small forest enterprises to develop and become more financially sustainable, and does not mention carbon or other environmental issues.[130] Other studies take a similar approach.[131, 132]

From the poverty alleviation and livelihoods perspective, the principal interest in REDD and other new financing models, such as payments for ecosystem services, is that they could provide new sources of finance for poverty alleviation approaches, if it can be demonstrated that carbon and environmental goals are achievable as by-products or co-benefits.

The need to achieve poverty alleviation, sustainable livelihoods and carbon and environmental benefits within forested areas in tropical Africa is based on extraordinarily challenging realities. Many of the areas where community forestry projects are sited or planned are places where high forest carbon values, important forest ecosystem services, low per capita incomes, low economic growth and high population growth all coexist. In the past there has often been a bifurcation in approaches to tackle these challenges, with development organisations addressing poverty and rights issues, and conservation organisations tackling biodiversity and forest protection. Can REDD act as the spearhead of an integrated approach to all of these challenges, or should development and carbon goals be pursued separately? The examples explored in the **Interventions and responses** section seem to indicate that integration can work in some contexts, but not necessarily in all. Even within the range of development goals, success is contingent on a number of variables, including the state of forest regulation and access to markets.

Amongst international institutions and NGOs there are a significant number of organisations – including **Center for International Forestry Research (CIFOR), Rights and Resources Initiative (RRI), Forest Trends, Global Witness, International Institute for Environment and Development (IIED)** and the **Rainforest Foundation** – which back this 'third way' as one of the best available means to achieve REDD goals, as well as improving incomes and securing rights. But these represent only one strand of a complex sectoral landscape.

Many in the development community who work on community forestry remain principally focused on poverty alleviation as the primary goal, with carbon conservation seen as a low priority. Since the 1970s (particularly in the last decade), many European bilateral development agencies (especially **DFID**, **NORAD**, **SIDA**, **FINIDA**, **AfD**, and **SNV**[133] have all supported community forestry initiatives in Africa, often with a combination of funding and active involvement in the framing of community forestry policy and regulations.

4.3.3 Community forestry as a REDD strategy?

There is a large body of research on community-based resource management that underpins much current thinking on community forestry. In particular, the work on theoretical 'social-ecological systems' by Nobel Laureate Elinor Ostrom[134-136] has been highly influential, showing that building these organisations is dependent on the dynamic interaction between numerous variables.

Broadly, four main factors dictate stability and success: the resource system (type, size); the resource units (value, mobility); the governance system (regulation, structure); and the users (number of users, location). In general, the larger the system, the less stable and successful it tends to be, but outside of this, generalisations are hard to make. This begs a number of questions on decentralisation in the REDD context. If successful local participation and control is critical, will governments be willing to cede the authority to expend REDD budgets down to the level of community forest management? How autonomous are they likely to be?

The effectiveness of community forestry as a REDD intervention depends on one critical factor: the extent to which safeguards can or should be built into community forestry projects to ensure that forest carbon is protected and enhanced within part of the forest area. If this can be achieved, community forestry could become an integral part of REDD strategies, both as the management basis for small projects and as a core component of large-scale schemes.

At one level, the omens are good, because of widespread agreement on the drivers of deforestation. A 2008 **Rights and Resources Initiative (RRI)** study notes: *'demands on forest lands are growing at an unprecedented pace. These demands include agro-industrial and silvicultural plantations, pasture lands, natural forest concessions, and mines…with population growth and migration, more forest lands are being colonised as part of agrarian reforms and spontaneous occupations.'*[124]

But in relation to safeguards, there are real difficulties. A core proposition of the rights-based approach to community management of forests is that communities (whether as a collective, or at the tribe, family or individual level) should have secure land tenure. But does this lead to effective conservation of forests? Not necessarily, as noted in a separate RRI study: *'in some cases, strengthened property rights by communities and households will lead to increased logging or land clearing. In other cases it will lead to improved conservation.'*[137] The tension inherent in the rights-based approach to carbon protection is clear: the right to destroy carbon has pre-eminence over the responsibility to protect. Below, we explore the track record of community forestry in three key countries: Cameroon, the DRC and Tanzania.

4.3.4 Cameroon

The legal framework for community forestry in Cameroon is based on the 1994 Forest Code, in which community forests are defined as forest areas in the *'non-Permanent Forest Domain'* (NPFD), a land use designation that permits timber extraction, agriculture, mining, and other utilisation activities. Each community forest must not exceed 5,000 hectares, and must be managed by village communities following a simplified management plan that excludes the use of heavy machinery. Unlike commercial logging concessions, community forests do not pay forest taxes.

From a REDD perspective, community forests in Cameroon are highly significant because they are located in areas where the bulk of deforestation occurs: along roads, in relatively populated areas of the NPFD, often close to major cities, and in already degraded forest that is more vulnerable to fires and attractive to shifting cultivators. In addition, the potential to create new protected areas is very limited in these regions, because of the presence of substantial human populations. The theory is that an expansion of community forests into those areas will be the best defence against further expansion of croplands: where community forests exist, land tenure is asserted and therefore potential expansion of agriculture or biofuel plantations is curtailed.

In practice, the first decade of community forestry in Cameroon has produced mixed results. Corruption and elite capture of benefits have been widely reported, including rental of lands to informal loggers. One consultee noted *'The reality of community forests is that the best trees are creamed off by loggers, and that's it for decades. This is looting.'* A 2007 study for CIFOR[138] noted that community forests in Cameroon result in *'ecosystem degradation due to the combined weakness of institutional arrangements, the personal enrichment of individual management committee officials, the maximization of profits by forest contractors, and the lack of control by regional forestry service.'*

Many participants cite the high administrative costs and long time frames involved in obtaining *'Authorisation of Cutting'* as the principal obstacle. Difficulties in obtaining authorisation encourage the illegal rental of lands to informal loggers and thus a higher probability of more indiscriminate logging.

The principal argument in favour of community forests in Cameroon is that – at least potentially – they could produce an improvement in REDD terms by comparison with the alternatives: commercial logging concessions, and informal (often illegal) small-scale logging. The recent move to create clusters of community forests is seen as a positive step by many NGOs, donors and practitioners in Cameroon, largely because it can produce economies of scale (capacity building, management and transport, market access for timber and non-timber forest products). Coordinated management plans can also target particular tree species and types of wood processing, leading to greater efficiency in utilisation. SNV is providing support for a cluster of 44 community forests covering a total area of 180,000 hectares (human population in the area is 40,000). Another cluster is supported by a partnership between Centre pour l'Environnement et le Développement (CED),[139] Equifor, and Friends of the Earth.[140]

One option to protect Cameroon's community forests is to leverage other ecosystem assets in addition to carbon. *Payments for ecosystem services (PES)* could be made to communities, increasing the financial incentive to protect local forests. A recently launched pilot PES project in several community forests in southern Cameroon may be a step toward proving this model. Run by CED, with oversight provided by BioClimate Research and Development (BR&D) and Rainforest Foundation UK, and funded by DFID and the Plan Vivo Foundation, this aims to make payments conditional on restoration of carbon stocks, plus a premium for biodiversity. In addition, resources will be invested in agricultural intensification (shade-grown cocoa), as well as tree planting.

The project is seen as one of a handful of pioneer projects selected by DFID to receive start-up funding ahead of the first round of initiatives that will be financed by the Congo Basin Forest Fund (CBFF).[141] Cameroon was chosen as the initial focal point because it is currently the only Congo Basin country to have a policy framework that is conducive to the expansion of community forestry.

Practitioners focused on PES schemes in Cameroon emphasise that the key to forest protection is essentially about developing smart strategies that maximise the value of forest resources. Communities will be more likely to manage their forests sustainably if the benefits are clear. One example is the management of valuable tree species, such as the moabi. The oil from this slow growing tree is far more valuable than its timber. If trade in moabi oil can be stimulated, this can result in payments to local communities who then have a vested interest in moabi protection. Other promising non-timber forest products include the kernels from azezang nuts and oil from wild mango. They are all in high demand locally, regionally (especially in Nigeria) and in developed countries.

4.3.5 The Democratic Republic of Congo (DRC)

The enactment of the 2002 Forest Code began the process of creating a legal framework for forest land use designations, after the years of civil war. It introduced legal provisions for communities to obtain exclusive rights and official titles over a portion or the entirety of their customary forest. The Code thus paves the way for community forestry in the DRC, referred to as *'Forêts des Communautés locales' (FCL) and 'Concessions des Communautés locales'* (CCL). There is uncertainty on the distinction between FCL and CCL (two of the four decrees that remain to be enacted to implement the Forest Code are relevant to community forestry), but CCL should correspond to the area of exclusive rights over the timber resource for local communities, while FCL should be a broader category including CCL but also forests used both by communities (for non-timber forest products, or NTFPs) and other land uses, including commercial logging, buffer zones, and protected areas.

Can empowerment of forest communities and REDD success be harnessed in a single strategy, or do they need to be pursued separately? The overall context is that this is a country in the very early stages of economic recovery after decades in which the infrastructure (logistical, industrial, agricultural, and political) has been badly corroded.

The UK's Department for International Development (DFID) has responsibility for delivering the UK's contribution to the Congo Basin Forest Fund, within which the DRC (as the largest forested country in the Basin) is a major focus. It also has a remit to develop community forestry in the DRC. A DFID-commissioned report by the UK NGO **Forests Monitor**[129, 142] sheds valuable light on the options, and shows how formidable the challenges are if community forestry in the country is to become aligned with REDD goals.

The report notes: *'since the stated aim of the [forest management] community forestry project is to improve livelihoods and reduce poverty for forest and rural communities, the very reason for engaging with the possible opportunities REDD may provide is for the social benefits it potentially offers, whether these are directly or indirectly accrued to community members in the form of incomes or the provision of social services. This issue will need to be monitored and be part of any REDD advocacy efforts of the development community and civil society both internationally and within DRC.'*

This confirms one of the major fears of many REDD participants: that a range of civil society groups and donors place social and economic benefits in forest communities ahead of carbon conservation. The report goes on to state: *'many of the disappointing social results [in community forestry projects] have occurred because the implementing intermediaries have focused more of their resources and activities on conservation and carbon sequestration. Many intermediaries were international conservation organisations rather than development focused NGOs' (Boyd et al, 2005).*

Another fear of many REDD participants is that development NGOs and governmental organisations will seek to capture REDD revenues in order to pursue social and economic benefits, and a worrying signal emerges in another part of the report to this effect: *'developing community forestry is integral to the desire of the DRC government to find alternative ways to manage and economically use their forest resources. Part of the original concept and vision of the proposal placed an emphasis on connecting community based producers with international markets in timber, environmental services (with a focus on carbon) and other non timber forest products.* ***As well as being inspired by new potential opportunities generated by climate change****, the idea is to provide an alternative to the DRC's reliance on the industrial forest logging concession system. The aim is to introduce a way to achieve transformational development that can address poverty by enabling forest communities to capture real and direct benefits from assets in their environment as well as contributing to long term national development.'*

The sentence in bold is highlighted to emphasise the danger. REDD is desirable because of the potential additional finance that it could provide, which would then be utilised to pursue social and economic development goals, including logging of forest resources through community forestry. This perception of REDD as a gravy train ignores its rationale. REDD has come into being as a response to rising awareness of the criticality of reducing greenhouse gas emissions. If the necessary reductions are not achieved, global temperatures will rise. The science indicates that the highest increases will occur in the tropics, leading to loss of freshwater resources, shrinkage or drying out of forests, and reductions in soil fertility and cultivable land. Future generations of forest communities in the DRC could pay dearly for this narrow view of social and economic benefits.

As we see below in the section on community forestry in Tanzania, the model can be implemented in a way that achieves significant carbon gains. The block in this example seems to be a failure to grasp the importance of REDD at a fundamental level, and an inability to see that forest carbon conservation can be the friend of forest communities rather than inimical. Community management of forests could be one of the major achievements of the REDD era, leading the way to truly sustainable forest conservation across tropical Africa that will ultimately provide security for forest communities. But this can only happen if the model embraces the necessity of carbon safeguards (prohibitions on logging in set-aside zones, allowing forests to naturally regenerate in others, and ambitious goals for carbon gains).

4.3.6 Tanzania

In Tanzania, community forestry is known as *participatory forest management* (PFM). It was first trialled by NGOs and bilateral donors in the early 1990s and since then has become the central pillar of Tanzanian government forest policy, especially over the last decade.[143] PFM appears to enjoy very broad support from NGOs, both national and international, as well as the Tanzanian government and development agencies as a platform for achieving development and environmental conservation goals (see Box 6). Major international donors include the governments of Denmark, Finland and Norway and the World Bank.[33, 144]

In terms of scale and the level of support received, PFM appears to be successful. Tanzania has some of the most well-developed community forestry policies in tropical Africa,[32] and the government aims to scale up PFM across the entire country to bring all public forests – about 20 million hectares – under community management.[145]

Why has the Tanzanian government made such a substantial commitment to legally recognise communal ownership of natural resources? The public rationale is that these open access forests are under high pressure – from illegal logging, charcoal production, fires, and conversion to agriculture. PFM provides a framework for bringing public forests under sustainable management while generating new sources of income and improving livelihoods. But analysis of the forces at play at the inception of PFM provides some additional perspectives that shed light on the interplay between economic, social and political factors.

Box 6: Case study: Mpingo Conservation and Development Initiative[146]

Introducing new ways of earning income that reduce deforestation and degradation – often called 'sustainable livelihoods' – is a key objective of many community forestry projects. One interesting example of this kind of project encountered in Tanzania was the Mpingo Conservation and Development Initiative (MCDI).

MCDI is working with several villages in the district of Kilwa, on the south-east coast of Tanzania, to protect their community forests by helping them to earn more money from the sale of wood from the mpingo tree. Mpingo is the Swahili name for the East African Blackwood, a species that is prized by wood carvers, most famously the Makonde tribe of southern Tanzania, and instrument makers from around the world, for the striking black colour of its heartwood. Mpingo is most commonly used to make clarinets, oboes, and bagpipes. Today, mpingo can only be found in commercially exploitable quantities in Mozambique and Tanzania, and it is under threat from illegal logging, charcoal making and agriculture.

MCDI is helping these villages achieve Forest Stewardship Council (FSC) certification for the harvest and trade of mpingo wood, and connecting them with woodwind instrument makers around the world. Two villages successfully achieved FSC certification in April 2009, reported by MCDI as the first communities to do so in Africa, and in June 2010, the supply chain was completed when an instrument maker based in the UK agreed to buy timber.[147] MCDI reports that this project could increase the amount that the villages can earn from the sale of mpingo from about $0.10 per log to almost $20 per log. By greatly increasing the value that communities can derive from their trees, the hope is that they will have a much greater incentive to protect them.

4.3.6.1 Background to the rise of PFM in Tanzania

The financial crisis of the 1980s triggered the collapse of the industrial timber sector in Tanzania.[148] Profits from the timber trade, and along with it revenues for the government, dropped sharply. The collapse of the timber sector was also related to perceptions of the low economic value of Tanzania's forests, many of which are dry or semi-dry, with slow growing trees. Unlike Congo Basin countries such as Gabon, the DRC and Cameroon, Tanzania has fewer high value hardwood trees (for example, teak and African mahogany). This economic situation produced several consequences that favoured the development of PFM as an alternative to commercial logging.

Central government was facing the limitations of a centralised approach: Tanzania has almost 35 million hectares of forest,[26] and with reduced revenues the incentives to bring all of this under government control were weak. Where this was attempted it was met with opposition. Plans to create new forest reserves in northern Tanzania were resisted by local communities, some of which began rapidly clearing forest to secure their land ownership. Furthermore, there was a belief, both inside and outside government, that the PFM trials going on simultaneously in the same region were having a greater impact on improving forest condition than government could.

The PFM trial area was made up of heavily degraded miombo woodland – a semi-dry, slow growing, lowland forest type, and thus of low economic value in timber terms.[148] Additionally, the area was not considered as valuable in terms of ecosystem services (water) or biodiversity as the forests of the Eastern Arc Mountains. It is noteworthy that these latter forests largely remain under central government ownership, though many are co-managed with communities through PFM.

The financial crisis increased Tanzania's dependence on foreign aid, which in turn gave donor countries greater leverage in pushing for reform – pursuing PFM would deliver greater revenues, through increased donor support, than pursuing timber production. From the donor perspective, one of the attractions of PFM was that aid funds could be routed direct to communities, thus bypassing the government. The Swedish International Development Cooperation Agency, SIDA, played a key role, providing 50 per cent of foreign aid to forestry in Tanzania from 1973 to 1998.

MCDI has helped communities in Tanzania increase the amount they can earn per log from only 10 cents per log to $20 per log.

Courtesy of Jasper Makala/Mpingo Conservation and Development Initiative (MCDI)

A third factor was the perceived rise of global conservation values. Tanzania is home to the Serengeti, one of the great flagship natural ecosystems in the world, and has long attracted strong ecotourism revenues and media attention. Responding to these multiple pressures, the government's Forestry and Beekeeping Division (FBD) shifted priorities away from producing timber to conserving forest ecosystems.

PFM provided two incentives from an FBD perspective. It offered the opportunity to outsource the costs of forest management to communities, at a time when central government resources for the sector were not available.[149] It also ensured continued donor aid support: with timber values of most of Tanzania's forests considered to be quite low, cooperating with donors was a more lucrative source of funding. Because of this, donors have continued to have some leverage on forestry policy.

4.3.6.2 Results of PFM and future scenarios

PFM appears to enjoy strong and very widespread support in Tanzania as a platform for the conservation, management and sustainable use of Tanzania's forests, while creating new sources of income for communities. But how successful is PFM?

Research to date on PFM effectiveness has tended to focus on the comparative impacts of forests under PFM and forests not under PFM (see, for example, the case study of Handei Village Forest Reserve in Box 7).

This research suggests that forests under a PFM regime fare better than forests on general land, with no formal management regime, as well as government-owned forest reserves, according to a number of indicators. These include a higher number of live and naturally dead trees; bigger trees, with thicker trunks and taller crowns; reduced cutting of timber and poles; reduced incidence of forest disturbance, including fires, trap setting, wood sawing, charcoal making, and farming; and positive views on improving forest condition by villagers in a survey.[143, 149, 150]

Other case studies have indicated that carbon stocks in forests under PFM can grow and can sequester between 5 and 7 tonnes of CO_2 per hectare per year.[151, 152] This body of research is not conclusive, for a number of reasons, including the small number of case studies, short time frames, leakage issues, and a lack of clarity on additionality or impact of the projects.

Box 7: The KTGAL project and community carbon forestry

The KTGAL (Kyoto: Think Global, Act Local) is a Dutch-based project led by Margaret Skutsch of the University of Twente, with funding provided by the Dutch Development Corporation during the project's first phase (2003–2009). KTGAL has worked on developing methods for community carbon monitoring, measuring the growth rates of carbon associated with community forest management, and lobbying the policy-making process with a view to ensuring that community carbon forestry has a place in the global climate change mechanisms, particularly under REDD-plus.[153-156]

Research teams have worked in three areas: the Himalayas, and East and West Africa, resulting in a slew of papers and case studies that shed much valuable light on the opportunities and constraints for community forest management in the carbon context. A summary of results from 13 case studies carried out by KTGAL seeks to show that 'local communities in remote parts of the developing world are more than able to comprehend the potential of maintaining forest or planting trees for the purposes of carbon mitigation, and that they recognise that they themselves can benefit from this mitigation, if a suitable reward system is constructed using the market value of carbon to create incentives.' In addition, the case studies seek to demonstrate that local transaction costs can be considerably lowered if local people themselves perform a large share of the carbon measurement and monitoring activities.

Handei Village Forest Reserve, Tanzania

Handei Village Forest Reserve is located in the Eastern Usambara Mountains, in the north-east corner of Tanzania, and has worked with the KTGAL project. The Reserve consists of 156 hectares of evergreen forest, and has been under village-based forest management since 1996. Before then, the forest was 'open access', with no formal management plan, and was considerably degraded by agriculture and uncontrolled timber harvesting, impacting local water supplies. Under the current management, forest utilisation (ecotourism, timber harvesting, dry firewood collection, traditional medicines collection) is confined to a buffer zone of 50 metres from all sides of the forest boundary, and is not allowed within the forest interior.

These controls appear to be working. Measurements of growth rates in the reserve in 2005/2006 show that it is sequestering 3 tonnes of carbon per hectare per year – about 468 tonnes of carbon a year for the whole forest. By comparison, the unmanaged forest surrounding the reserve stores roughly half the carbon, and remains degraded by agriculture and logging for timber and woodfuels.

The direct cost of establishing PFM depends on a range of factors: size and geography of forest area; number of villages involved; and the education levels and attitude of the community. Consultees cited a range of costs for establishing PFM in a single forest (area unspecified), with $10,000–$30,000 being the most common.

These amounts sounds small in relative terms, but the total area of planned PFM is very large. The government is reliant on international donors to achieve this. The World Bank and the governments of Finland, Denmark and Norway are major funders of PFM. The high conservation value that the international community places on the Coastal Forests and Eastern Arc Mountains (both being internationally recognised biodiversity hotspots) is perhaps one reason for this bias in the rollout of PFM across Tanzania.

These donor programmes are based on a goal of developing PFM as a platform for the conservation, management and sustainable use of Tanzania's forests, while creating new sources of income for communities. A range of sustainable livelihoods are promoted in PFM villages, including sustainable timber harvest or charcoal production, wood carvings, beekeeping, harvesting forest fruits and other foods, and medicines and butterfly farming. Activities outside the forest boundary, which aim at reducing the community's impact on the forest, are also encouraged in many PFM sites: examples include agroforestry, pig or chicken farming, and establishing woodlots to provide fuel.

4.3.6.3 Future challenges

The creation of livelihoods opportunities requires significant investment in building capacity, training and education in new activities, strengthening governance standards in village leadership, and creating market access for forest products. Most of this work is carried out by NGOs. Current PFM analyses of costs are limited, but it seems likely that PFM implies a high cost per hectare relative to protected areas, because 'win-wins' are explicitly sought: livelihoods benefits as well as forest protection. Some people consulted observed that the majority of PFM costs are incurred after the documents have been signed and government has handed over management rights for the forest. To a certain extent this may cast PFM in a rosy light, when viewed from the government perspective. If donor support were withdrawn, the PFM model might prove financially unsustainable.

One potential threat to PFM in Tanzania is the possibility that the government has the legal powers to revoke a VLFR. This has not yet occurred, but could potentially be triggered by a number of factors, including withdrawal of donor support, or any of the set of deforestation drivers, including revenue opportunities from mineral exploitation and pressure for conversion to agriculture. On the other side of the equation, the institutionalisation of REDD finance might strengthen PFM in Tanzania, if the model is deemed allowable.

4.3.7 Community forestry and protected areas – which is better for carbon?

As explored in earlier chapters and in **Conservation**, the issue of protected areas has often proved divisive within the development and forests community. This spills over into the assessment of community forestry, because many rights-based and development NGOs and practitioners argue that protected areas should be taken out of public ownership and managed by communities.

Although most of the commentary to date has focused on the biodiversity conservation purpose of protected areas, the fundamental issues remain the same for carbon conservation, perhaps more so, because of the evidence base demonstrating the strong correlation between forest carbon and protected areas in the tropics. Which approach is more effective in carbon terms? A study by the **Rights and Resources** Initiative argues that:

'[Protected areas have had] *negative effects on the livelihoods, wellbeing, health, and culture of the millions of people excluded from forest areas. It is estimated that globally there are 130 million conservation refugees.*

There have been widespread human rights abuses related to government enforcement of forest protection laws. Analysts have commented that preserving biodiversity for its own sake is failing as a conservation strategy, and that even if protected areas have been important for protecting rare species and habitats, it is not clear that the human displacement conducted justifies this marginal gain.'[124]

The report goes on to conclude that forest biodiversity conservation goals (and, by implication, forest carbon conservation) can be better achieved through local tenure and management. Its claims that inhabited reserves tend to inhibit deforestation are not, however, clearly substantiated. The report notes, for example, that *'in Uganda, well-known and enforced forest property rights are associated with improved forest condition.'* The conditionality of the statement is far from convincing, and the overall context is missing. As our case study on the SGPS scheme in Uganda shows, Ugandans have pressing needs for woodfuel, charcoal and timber. These are economic imperatives that will continue to exert intense pressure on forests regardless of whether or not lands are designated as protected or community-based areas, unless the fundamental supply problems are resolved.

A report by **Forest Trends** is similarly bold in assertion and poor on evidence, claiming that *'the model of "wilderness" preservation borrowed from the United States has proven too limited to meet the challenge of conserving biodiversity and ecosystem functions.'* It goes on to note that protected areas are only effective in certain conditions, and cover not much more than 10 per cent of the world's forests, and that they have had limited funding and are not likely to have funding increased in the future. All of these statements are accurate, but it does not necessarily follow from this that all protected areas are ineffective and should be dispensed with. The answer might be to do the opposite: increase protected areas, and increase funding via REDD so as to improve their effectiveness.

The report then goes on to argue that *'community forest management has therefore been recognized as an essential means to sustainably manage forest resources while supporting local livelihoods and cultural values and being more respectful of community rights and assets. Community forestry management is also emerging as more effective in reducing pressures on "wilderness areas" and better at providing compatible means of livelihood to people living within priority biological corridors.'*[128] Again, these are assertions offered without substantiation.

As with so many other issues on tropical forests, the road forward is likely to embrace both approaches. As we conclude in the **Conservation** chapter, the concentration of carbon stocks in tropical African protected areas indicates a clear need to maintain them, and to improve funding and management so they can more effectively conserve forests. But there is also a pressing need to improve and scale up community forest management. Rather than arguing for one or the other approach, NGOs should focus on defining where and how each model needs to be adopted.

This leads to the need for better research, preferably site-based analysis, rather than the macro-level modelling that characterises much applied research on land use. Two recent studies illustrate the dangers of the latter. The first of these analysed 80 community-managed forest areas in 10 tropical countries across Asia, Africa and Latin America and found the larger the area and the greater the rule-making autonomy at the local level, the higher the amount of carbon stored and greater the benefits to local livelihoods. It also examined the effect of ownership and found that when communities owned the forest they tended to defer use, diminishing their own livelihood benefits and increasing carbon storage. On the other hand, there was a higher probability of overuse and less carbon storage on state-owned land.[157] The second study analysed remote sensing imagery across the tropics and compared effectiveness of protected areas against that of multiple use and indigenous areas, using forest fires as the best proxy

available for deforestation. Multiple use areas generally provide greater deforestation reductions than protected areas, and indigenous areas have an even higher positive impact.[158]

Studies of this type are of dubious value. Local variations in governance, carbon intensities and activities across ten countries in three continents (in the case of the first study) will inevitably be very great, so much so that any macro-level interpretation will be contentious. For the second study, the selection of only one driver of deforestation (forest fires) introduces huge uncertainty. There are many drivers of deforestation, and their interactions are complex.

4.4 Converting logging concessions to forest conservation areas

Most of this report is concerned with detailing the threats to Africa's forests and suggesting interventions that aim to limit these negative impacts. Approaches that fully protect and restore tropical African forests have largely been limited to protected areas (see the **Conservation** chapter). One major new opportunity, however, is the conversion of dormant timber concessions into forest conservation areas: this means preventing timber harvest from going ahead; addressing local drivers of deforestation (illegal logging for timber or woodfuels, hunting, agriculture, artisanal mining); and selling the carbon credits generated as the forest grows and sequesters carbon.

Previously, halting industrial logging and handing forests over for carbon conservation would not have been economically feasible because the opportunity costs would have been too high. The emergence of REDD and the potential revenues that could be generated from selling forest carbon credits provides the possibility of shifting this equation. Our preliminary calculations, below, demonstrate that REDD could make forest conservation competitive with industrial logging.

The Ngoyla-Mintom forest in Cameroon provides a case study. Since 2002, the Cameroonian government has offered to lease Ngoyla-Mintom – some 830,000 hectares of dense forest in southern Cameroon – to conservationists for the price of $1.6 million per year.[159] As of March 2010, an application is being developed to keep the forest as a conservation area for $10 million for 5 years.[160-162]

Data on the value of logging concessions, from the perspective of the government receiving revenue, is difficult to locate.[163] This sort of information is often not disclosed by timber companies. It is also challenging to find figures for the purposes of comparing the value of logging concessions with the value of a large-scale REDD project: introducing discount rates and other assumptions introduces substantial error margins. Rhett Butler, of the well-known environmental blog and news portal Mongabay, provides an estimate for the Net Present Value (NPV)[viii] of converting Ngoyla-Mintom into a logging concession of approximately $26 million.[164] That value rises to $64 million if the forest was converted to a REDD site. In other words, the potential value of the REDD project is estimated to be more than twice that of the logging concessions.

This is only one forest, in only one tropical African country. However, the assumptions are generally conservative and, as we demonstrate below, REDD remains competitive even if we alter some of the variables against REDD.

The avoided deforestation is estimated to be 1 per cent, which is equal to the annual deforestation rate for Cameroon in 2000–2005 reported by the FAO.[26] The impact of logging (the amount of carbon lost in the logging process) is assumed to be around 40 tonnes per hectare. This is comparable with estimates for the impact of industrial logging reviewed above. The price per tonne of CO_2 (the unit of carbon credits) is assumed to be $3; if REDD projects successfully enter either the US or EU compliance markets, this figure could rise significantly. Finally, the discount rate (the rate at which future revenues are discounted to reflect their value today) for both the REDD project and the logging concession is set at 5 per cent.

4.4.1 What if the rate of deforestation is different?

These figures are estimates and are also location specific, and are offered as examples. The key insight that these calculations provide lies in the fact that the REDD option appears to be very robust (in economic terms) when compared with the timber concession option. Table 10 shows the additional profit (or loss) generated by the REDD concession for a range of different carbon prices and deforestation rates. For example, if we assume a deforestation rate of only 0.5 per cent, and the price of carbon credits at $3, the NPV of the REDD project is still worth $6 million more than the NPV of the logging concession. Only under quite extreme assumptions is the logging concession more valuable: if avoided deforestation is only estimated to be 0.25 per cent, then the REDD project is still competitive when the price of carbon credits is $5. The overall picture, therefore, is unmistakeably one of REDD competitiveness and value.

4.4.2 What if the discount rate is higher?

It could be objected that a REDD project is inherently more risky than a logging concession. Timber concessions supply a well-established global market, which is not yet true for REDD projects, and REDD project models are still being tried and tested. A discount rate of 5 per cent for a REDD project could, therefore, be considered too low. Table 11 shows the estimated profit (or loss) of the REDD project in this example for a range of discount rates (up to 20 per cent) and carbon prices. We assume a deforestation rate of 1 per cent.

Only under one scenario is the REDD concession estimated to be non-competitive with a logging concession: where the discount rate is 20 per cent and the price of carbon credits is $3. In other words, only if one assumes a very high level of risk in REDD projects and no future increase in the price of carbon does the logging concession look more viable.

These are initial calculations, which apply specifically to the Ngoyla-Mintom forest in Cameroon. Nevertheless, they lend credibility to the premise that dormant logging concessions combined with the emergence of REDD monies represent a unique opportunity for protecting Africa's tropical forests. And a more optimistic perspective might see the data as reflecting the high end of the current profitability of logging concessions. Comparable figures for other major timber-producing countries are hard to locate, but some evidence suggests that the timber industry is much more developed in Cameroon than in some other countries in the Congo Basin.

Table 10: NPV of REDD versus logging under different deforestation rates and price of carbon ($)

Avoided Deforestation	Price of carbon $3.00	$5.00	$7.00	$9.00
0.25%	-10,069,787	550,355	11,170,497	21,790,639
0.50%	5,860,426	27,100,710	48,340,994	69,581,278
1.00%	37,720,852	80,201,420	122,681,988	165,162,557
1.50%	69,581,278	133,302,130	197,022,983	260,743,835
2.00%	101,441,704	186,402,841	271,363,977	356,325,113

Table 11: NPV of REDD versus logging assuming different discount rates ($)

Price of Carbon Credits	Discount rate 5%	8%	10%	15%	20%
$3	37,720,852	21,998,294	14,936,566	3,808,940	-2,413,311
$5	80,201,420	53,997,156	42,227,610	23,681,566	13,311,149
$7	122,681,988	85,996,019	69,518,654	43,554,193	29,035,608
$10	186,402,841	133,994,313	110,455,220	73,363,133	52,622,297
$12	228,883,409	165,993,175	137,746,264	93,235,759	68,346,756
$15	292,604,261	213,991,469	178,682,831	123,044,699	91,933,446
$20	398,805,681	293,988,626	246,910,441	172,726,265	131,244,594

Table 12: Comparison of logging concessions and government revenue in Congo Basin countries

(millions of hectares)	Cameroon	CAR	Republic of Congo	DRC	Equatorial Guinea	Gabon	Total
Land area	46.5	62.3	34.1	226.7	2.8	25.8	398.3
Dense forest area	21.4	8.2	25.9	124.5	1.8	21.2	203.2
Production forests	10.5	3.3	12	87	1.2	19	133
Timber concessions	7	3	10	22	1.2	12	55.2
Government revenue (2004–2005)	$40m	$10m	$20m	$3.8m	$14m	$50m	$137.5m
Revenue per hectare	**$5.71**	**$3.33**	**$2.00**	**$0.18**	**$11.20**	**$4.17**	**$2.50**

Source: Karsenty, A., *Overview of Industrial Forest Concessions and Concession-based Industry in Central and West Africa and Considerations of Alternatives*.[24]

Table 12 shows the estimated direct revenue that different African governments generate from the logging industry for 2004/2005. Cameroon, with only 7 million hectares of concessions, generated $40 million of revenue, compared to the DRC, which barely generated $4 million from some 22 million hectares of concessions. The implied revenue per hectare is $5.71 in Cameroon, more than any other country apart from Equatorial Guinea and over 30 times that of the DRC.

It therefore seems reasonable to suggest that the estimates for the profitability of logging concessions in Cameroon are probably at the higher end of the range for Congo Basin countries. REDD forest conservation areas may therefore prove more competitive with timber concessions in countries like the DRC and Republic of Congo.

5. Conclusions

5.1 Forest conservation is a better option for protecting carbon than forestry

Forestry can – in some circumstances – make a contribution to REDD goals. Selective logging and SFM practices in natural forests will reduce carbon emissions relative to complete forest clearance, and these approaches can in theory maintain a natural forest in a permanent state, if new forest growth replaces removals. Tree plantations can act like natural forests in carbon sequestration terms, sucking CO_2 down from the atmosphere as they grow. But these are high-risk bets: everything depends on the extent to which theory translates into practice. Supporters of selective logging and SFM can point to successful implementation, but opponents can cite plenty of examples where they have failed.

Should donors and funders who want to support forest conservation and enhancement in tropical Africa back forestry as a means to that end? At a fundamental level the answer is unequivocal – there is a better option. If the opportunity exists to fully protect a natural forest, then protect it. In practice, virtually no SFM/selective logging regime or plantation model can compete with a natural forest with respect to carbon storage, in the long term, assuming the forest can be left undisturbed. This applies equally for many degraded forests: left to themselves they will regenerate naturally, if the core ecosystem requirements (soil, rainfall, adequate animal and plant biodiversity) are still in place.

5.2 Converting logging concessions to forest conservation areas

Inactive logging concessions cover 55 million hectares in six central African countries, more than the size of Spain.[10] If activated for logging these would spew out vast emissions. The emergence of REDD means that forest conservation has the potential to compete with industrial logging as a revenue earner. Preliminary calculations suggest that REDD could be competitive with industrial logging in some Congo Basin countries if the price of carbon credits ($ per tonne of CO_2) is as low as only $3 with a deforestation rate of only 0.5 per cent. Donors and funders have a real opportunity here to make a difference, by targeting particular forests at scales of 100,000 hectares or more, and scoping the possibility of conversion through dialogues with governments, logging companies, NGOs and local communities.

5.3 Supporting timber plantations for the domestic market

Plantations dedicated to meeting the vast domestic demands in tropical Africa for timber and woodfuels could ease pressure on forests and free forests for carbon conservation. Our preliminary calculations, using Tanzania and Uganda as case studies, suggest that meeting national timber demand with plantations could be achieved with a land area equivalent to only 5–20 per cent of the forest area required to meet demand. For Tanzania, this would mean avoiding timber harvest in an area of forest 10 times the size of Greater London (1.6 million hectares).

5.4 Other forestry priorities

Other priorities include better regulatory regimes in the forestry sector, which could lead to a higher proportion of FSC or other certified products, and improved filtering out of illegal timber exports via the FLEGT initiative. But these gains will only have a marginal impact if the fundamental domestic demand drivers are not addressed. Similarly, Sustainable Forest Management (SFM) approaches may bring greater efficiency in logging and processing, and while that is desirable it should not be seen as a conservation solution.

Community forestry has the potential to reduce deforestation and degradation in those areas where population levels are high, and enforcing strict conservation of forest resources is infeasible (and not to mention unethical if doing so would deprive people of access to basic resources). It provides a platform for improving the sustainability of subsistence and commercial uses of forests by local people. However, in practice the track record has been very mixed between countries: in Cameroon, community forestry has not lived up to expectations, while in Tanzania it appears to be promising. It is too early to tell if community forestry has delivered a positive outcome in terms of reducing emissions from deforestation and degradation, but support from donors and funders could help develop a much needed concept of 'best practice' in community forestry and make this model work.

6. References

1. Westoby, J., *The Purpose of Forests: Follies of Development*. 1987: Basil Blackwell.

2. Westoby, J., *Introduction to World Forestry: People and Their Trees*. 1989: Basil Blackwell.

3. Putz, F.E., et al., *Background information on Reduced Impact Logging and calculations of carbon emissions - supporting material for Improved tropical forest management for carbon retention*. PLoS Biology, 2008. 6(7): p. 1368-1369.

4. Kauppi, P.E., et al., *Returning Forests Analyzed with the Forest Identity*. Proceedings of the National Academy of Sciences of the United States of America, 2006. 103(46): p. 17574-17579.

5. Black, R. (2010) *Forest loss slows, as China plants and Brazil preserves*

6. Hansen, M.C., et al, *Quantification of global gross forest cover loss*. Proceedings of the National Academy of Sciences of the United States of America, 2010. 107(19): p. 8650-8655.

7. Global Partnership on Forest Landscape Restoration. [cited 2009 17 November]; Available from: http://www.ideastransformlandscapes.org/.

8. International Tropical Timber Organization (ITTO), *ITTO Guidelines for the Restoration, Management and Rehabilitation of Degraded and Secondary Tropical Forests*. 2002. Available from: http://www.itto.int/en/policypapers_guidelines/.

9. Pearce, D., F. Putz, and J. Vanclay, *Sustainable forestry in the tropics: panacea or folly?* School of Environmental Science and Management Papers. , 2003.

10. Nasi, R., B. Cassagne, and A. Billand, *Forest management in Central Africa: where are we?* International Forestry Review, 2006. 8(1).

11. Globaltimber.org.uk. 26 March 2010]; Available from: http://www.globaltimber.org.uk/.

12. Aghalino, S.O., *British Colonial Policies and the Oil Palm Industry in the Niger Delta Region of Nigeria, 1900-1960*. African Study Monographs, Kyoto University, 2000. 21(1).

13. Amsallem, I., *Status and Trends in Forest Management in Central Africa,* in *Forestry Management Working Papers*. 2002, Food & Agriculture Organization (FAO). Available from: ftp://ftp.fao.org/docrep/fao/008/Y8127e/Y8127e.pdf.

14. Mongabay.com. *Congo cancels logging contracts covering 13 million hectares*. 21 January 2009 24 March 2010]; Available from: http://news.mongabay.com/2009/0121-congo.html.

15. BBC News. *DR Congo cancels timber contracts*. 2009 19 January 2009 24 March 2010]; Available from: http://news.bbc.co.uk/1/hi/world/africa/7838659.stm.

16. International Tropical Timber Organization (ITTO), *DRC cancels nearly 60% of timber contracts*. Tropical Timber Market Report, 2009. 14(2).

17. Global Witness. *Forest concession cancellations in DR Congo welcome, but widespread reforms still needed*. 27 January 2009 24 March 2010]; Available from: http://www.globalwitness.org/media_library_detail.php/707/en/forest_concession_cancellations_in_dr_congo_welcom.

18. Brown, S., *Impact of selective logging on the carbon stocks of tropical forests: Republic of Congo as a case study 2005*. Available from: http://www.usaid.gov/.

19. Feldpausch, T.R., et al., *When big trees fall: Damage and carbon export by reduced impact logging in southern Amazonia*. Forest Ecology and Management, 2005. 219(2-3): p. 199-215.

20. Putz, F.E., et al., *Improved tropical forest management for carbon retention*. Plos Biology, 2008. 6(7): p. 1368-1369.

21. World Resources Institute, *Climate Analysis Indicators Tool (CAIT)*. 2008. Available from: http://cait.wri.org/.

References continued

22. Debroux, L., et al., *Forests in Post-Conflict Democratic Republic of Congo: Analysis of a Priority Agenda*. 2007, CIFOR, CIRAD, World Bank and others.

23. Food and Agricultural Organization (FAO), *Forestry Outlook Study for Africa,* in *FAO Forestry Papers*. 2003. Available from: www.fao.org/docrep/005/Y4521E/Y4521E00.HTM.

24. Karsenty, A., *Overview of Industrial Forest Concessions and Concession-based Industry in Central and West Africa and Considerations of Alternatives*. 2007, CIRAD.

25. Milledge, S., I. Gelvas, and A. Ahrends, *Forestry, Governance and National Development: Lessons Learned from a Logging Boom in Southern Tanzania*. 2007, TRAFFIC East/Southern Africa, Tanzania Development Partners Group, Ministry of Natural Resources and Tourism: Dar es Salaam, Tanzania. Available from: http://www.traffic.org/forestry/.

26. Food and Agricultural Organization (FAO), *Global Forest Resources Assessment 2005*. 2006, FAO: Rome, Italy. Available from: ftp://ftp.fao.org/docrep/fao/008/A0400E/A0400E00.pdf.

27. Djiré, A., *Le secteur informel du bois d'oeuvre. Rapport d'appui à la revue économique du secteur forestier en RDC. Rapport technique, CIRAD*. 2003, Ministère des Finances, République Démocratique du Congo.

28. Tacconi, L., *The Problem of Illegal Logging, in Illegal Logging: Law Enforcement, Livelihoods and the Timber Trade*, L. Tacconi, Editor. 2007, Earthscan: London, UK.

29. Cerutti, P.O. and L. Tacconi, *Forests, Illegality and Livelihoods in Cameroon: Working Paper No. 35*. 2006, CIFOR: Bogor Barat, Indonesia. Available from: http://www.cifor.cgiar.org/publications/pdf_files/WPapers/WP-35.pdf.

30. Contreras-Hermosilla, A., R. Doornbosch, and M. Lodge, *The economics of illegal logging and associated trade*. 2007, OECD.

31. World Bank, *Strengthening Forest Law Enforcement and Governance: Addressing a Systematic Constraint to Sustainable Development*. 2006, World Bank: Washington, D.C., USA. Available from: http://www.illegal-logging.info/uploads/Forest_Law_FINAL_HI_RES_9_27_06_FINAL_web.pdf.

32. Wily, L.A., *Forest law in Eastern and Southern Africa: Moving towards a community-based forest future?* Unasylva, 2000. 51(203): p. 19-26.

33. Forestry and Beekeeping Division, *Facts and Figures: Participatory Forest Management in Tanzania*. 2008, MNRT, United Republic of Tanzania: Dar es Salaam.

34. WWF. *Sustainable forest management in Southeast Cameroon*. 28 August 2008]; Available from: http://www.panda.org/who_we_are/wwf_offices/cameroon/?uNewsID=144321.

35. Food and Agricultural Organization (FAO), *State of the World's Forests 2009*. 2009. Available from: ftp://ftp.fao.org/docrep/fao/011/i0350e/i0350e.pdf.

36. BBC News. *China opens coffers for minerals*. 2007 18 September 2007 15 May 2009]; Available from: http://news.bbc.co.uk/1/hi/world/africa/7000925.stm.

37. International Tropical Timber Organization (ITTO), *From forest tenure, governance and enterprise: new opportunities for livelihoods and wealth in Central and West Africa - Ghana Forestry Investment Paper*. 2009. Available from: www.itto.int/direct/topics/topics_pdf.../topics_id=32800000&no=41.

38. Government of Uganda, *The Uganda Forestry Policy*. 2001, Ministry of Water, Lands and Environment. Available from: http://www.sawlog.ug/downloads/The%20Uganda%20Forestry%20policy.pdf.

39. Congo Basin Forest Partnership (CBFP), *The Forests of the Congo Basin: A Preliminary Assessment*. 2005, Congo Basin Forest Partnership.

40. Attah, A., *Market Competitiveness of West and Central African Forest Products and services and the influence of Market Conditions on Forest Investments*. 2007. Available from: www.itto.int/direct/topics/topics.../topics_id=32800000&no=161

References continued

41. Canby, K., et al., *Forest Products Trade Between China & Africa: An Analysis of Imports & Exports*. 2008, Forest Trends and Global Timber (www.globaltimber.org.uk): Washington, D.C., USA and London, UK.

42. Illegal-logging.info. *Clarification on Gabon log ban*. 16 February 2010 18 June 2010]; Available from: http://www.illegal-logging.info/item_single.php?it_id=4205&it=news.

43. van Soest, D., *Tropical Deforestation: An Economic Perspective*. 1998, Rijksuniversiteit Groningen. Available from: http://arno.uvt.nl/show.cgi?fid=80333.

44. Lewis, S.L., et al, *Increasing carbon storage in intact African tropical forests*. Nature (London), 2009. 457(7232): p. 1003-1006.

45. Luyssaert, S., et al., *Old-growth forests as global carbon sinks*. Nature, 2008. 455: p. 213-215.

46. Baker, T.R., et al, *Increasing biomass in Amazonian forest plots*. Philosophical Transactions of the Royal Society London, 2004. B (359): p. 353-365.

47. Oliveira, P., et al, *Land-Use Allocation Protects the Peruvian Amazon*. Science, 2007. 317(5842).

48. Global Witness, *Vested Interests: Industrial Logging and Carbon in Tropical Forests*. 2009. Available from: www.globalwitness.org.

49. Asner, G.P., et al, *Selective logging in the Brazilian Amazon*. Science, 2005. 310(480).

50. Asner, G.P., et al, *Condition and fate of logged forests in the Brazilian Amazon*. Proceedings of the National Academy of Sciences of the United States of America, 2006. 103(34).

51. Food and Agricultural Organization (FAO), *Road Infrastructures in tropical forests. Road to development or road to destruction?* 1999.

52. Laporte, N.T., et al., *Expansion of Industrial Logging in Central Africa*. Science, 2007. 316: p. 1451.

53. International Tropical Timber Organization (ITTO), *Achieving the ITTO Objective 2000 and sustainable forest management in Papua New Guinea: Report of the Diagnostic Mission*. 2007.

54. Pinard, M.A. and F.E. Putz, *Monitoring carbon sequestration benefits associated with a reduced-impact logging project in Malaysia*. Mitigation and Adaptation Strategies for Glovbal Change, 1997. 2: p. 203-215.

55. Putz, F.E., et al., *Reduced-impact logging: Challenges and opportunities*. Forest Ecology and Management, 2008. 256(7): p. 1427-1433.

56. Redford, K.H., The Empty Forest. BioScience, 1992. 42.

57. Mongabay.com. *Hunting across Southeast Asia weakens forests' survival, An interview with Richard Corlett*. 08 November 2009 08 November 2009]; Available from: http://news.mongabay.com/2009/1108-hance_corlett.html.

58. Uhl, C.a.K., J.B.,, *Deforestation, Fire Susceptibility, and Potential Tree Responses to Fire in the Eastern Amazon*. Ecology 1990. 71(2).

59. Cochrane, M., *Fire science for rainforests*. Nature 2003. 421.

60. Siegert, F., et al, *Increase damage from fires in logged forests during droughts caused by El Nino*. Nature 2001. 414.

61. Nepstad, D., et al, *Large-scale impoverishment of Amazonian forests by logging and fire*. Nature 1999. 398.

62. Laporte, N., et al., *Reducing CO_2 emissions from deforestation and degradation in the Democratic Republic of Congo: a first look*. 2007, The Woods Hole Research Center.

63. Ecosystem Climate Alliance, *Trick or Treat? REDD, Development and Sustainable Forest Management*. 2009. Available from: www.ecosystemsclimate.org.

64. Environmental Investigations Agency (EIA), *Demanding Deforestation: What Lessons Can Illegal Logging and International Timber Trade Policy Teach Us For Effectively Reducing Emissions from Deforestation?* 2008. Available from: http://www.eia-global.org/PDF/REDDPoznan_Briefing.pdf

References continued

65. Environmental Investigations Agency (EIA), *Putting the Brakes on Drivers of Forest Destruction: A Shared Responsibility*. 2009. Available from: http://www.eia-international.org/files/news572-1.pdf.

66. Forests and the European Union Resource Network (FERN). 17 October 2009]; Available from: www.fern.org.

67. Forests Monitor. [cited 2010 5 March 2010]; Available from: http://www.forestsmonitor.org/

68. Greenpeace, *Africa's Forests - Vital for Our Climate*. 2007. Available from: www.greenpeace.org.

69. Greenpeace International, *Carving Up the Congo*. 2007. Available from: http://www.greenpeace.org.uk/media/reports/carving-up-the-congo.

70. Greenpeace International, *Conning the Congo*. 2008. Available from: www.greenpeace.org.

71. Rainforest Foundation UK, *Forest Management Transparency, Governance and the Law: Case studies from the Congo Basin*. 2003. Available from: http://www.rainforestfoundationuk.org/files/AFLEG%20report%20final%20-%20Eng.pdf.

72. Rainforest Foundation UK, *The Use of Non-Timber Forest Products in the Congo Basin: Constraints and Opportunities*. 2007. Available from: www.rainforestfoundationuk.org.

73. Karsenty, A., et al., *Regulating industrial forest concessions in Central Africa and South America*. Forest Ecology and Management, 2008. 256: p. 1498-1508.

74. Tropical Forest Trust. [cited 2010 5 March 2010]; Available from: http://www.tropicalforesttrust.com/.

75. Center for International Forestry Research (CIFOR). 16 October 2009]; Available from: www.cifor.cgiar.org.

76. Rice, R., R. Gullison, and J. Reid, *Can sustainable management save tropical forests?* Scientific American, 1997. April 1997.

77. Pena-Claros, M., et al,, *Beyond reduced-impact logging: Silvicultural treatments to increase growth rates of tropical trees*. Forest Ecology and Management, 2008. 256: p. 1458-1467.

78. Boltz, F., et al., *Economic and environmental impacts of conventional and reduced-impact logging in Tropical South America: a comparative review*. Forest Policy and Economics, 2003. 5: p. 69-81.

79. Rice, R.E., et al,, *Sustainable Forest Management: A Review of Conventional Wisdom*. 2001, Conservation International. Available from: www.cabs.conservation.org.

80. Gullison, R., *Does forest certification conserve biodiversity?* Oryx, 2007. 37(2).

81. Gullison, T., et al., , *Logging Off: Mechanisms to Stop or Prevent Industrial Logging in Forests of High Conservation Value*. 2001.

82. Bowles, I.A., et al., *Logging and Tropical Forest Conservation*. Science, 1998. 280(5371): p. 1899-1900.

83. Lugo, A.E., *Will concern for biodiversity spell doom to tropical forest management?* The Science of the Total Environment, 1999. 240: p. 123-131.

84. Luckert, M. and T. Williamson, *Should sustained yield be part of sustainable forest management?* . Canadian Journal of Forestry Research, 2005. 35.

85. Wadsworth, F.H., et al., , *Liberation: Acceptable production of tropical forest timber. Forest Ecology and Management*, 2006. 233: p. 45-51.

86. Fredericksen, T., *Silvicultural intensification for tropical forest conservation*. Biodiversity and Conservation, 2003. 12: p. 1445-1453.

87. Sist, P. and N. Brown, *Silvicultural intensification for tropical forest conservation: a response to Fredericksen and Putz*. Biodiversity and Conservation 2004. 13: p. 2381-2385.

References continued

88. Sist, P., et al., , *Sustainable cutting cycle and yields in a lowland mixed dipterocarp forest of Borneo*. Ann. For. Sci, 2003. 60: p. 803-814.

89. Ruiz Pérez, M., et al., *Socioeconomic constraints, environmental impacts and drivers of change in the Congo Basin as perceived by logging companies.* Environmental Conservation, 2006. 33(4): p. 1-9.

90. Streck, C., *REDD+ Institutional Options Assessment: Developing an Efficient, Effective, and Equitable Institutional Framework for REDD+ under the UNFCCC*. 2009. Available from: www.REDD-OAR.org.

91. Braatz, S., *Sustainable management of forests and REDD+: Negotiations need clear terminology*. 2009. Available from: www.fao.org.

92. Sawlog Production Grant Scheme (SPGS), *Tree Planting Guidelines for Uganda*. Available from: http://www.sawlog.ug/Download2.html.

93. IPCC, *Annex 3A.1 in Good Practice Guidance for Land Use, Land-Use Change and Forestry*, J. Penman, et al., Editors. 2003, IPCC National Greenhouse Gas Inventories Programme. Available from: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_contents.html.

94. Chamshama, S. and F. Nwonwu, *Forest plantations in Sub-Saharan Africa: Lessons learnt on Sustainable Forest Management in Africa*. 2004. Available from: http://www.ksla.se/sv/retrieve_file.asp?n=749.

95. Marien, J.-N. and B. Mallet, *Nouvelles perspectives pour les plantations forestières en Afrique centrale*. Bois et Forêts des Tropiques 2004. 282(4).

96. Van Bodegom, A., J. Van den Berg, and P. Van der Meer, *Forest plantations for sustainable production in the tropics: key issues for decision makers*. Wageningen University & Research Centre, 2008.

97. International Tropical Timber Organization (ITTO), *Report on the market study on tropical plantation timber products*. Prepared for ITTO by STCP Engenharia de Projectos Ltda. ITTO Thirty-ninth session 6-11 November 2006. 2006: Yokohama.

98. World Rainforest Movement. 21 October 2009]; Available from: www.wrm.org.uy.

99. Forest Movement Europe, *Statement on Tree Plantations*, June 2009. 2009. Available from: http://www.wrm.org.uy/plantations/information/Statement_Tree_Plantations_2009.html.

100. The Forests Dialogue (TFD). *Dialogues on Intensively Managed Planted Forests.* [cited 2009 11 December 2009]; Available from: http://environment.yale.edu/tfd/dialogues/intensively-managed-planted-forests/.

101. Jindal, R., B. Swallow, and J. Kerr, *Forestry-based carbon sequestration projects in Africa: Potential benefits and challenges*. Natural Resources Forum, 2008. 32(2): p. 116-130.

102. Jacovelli, P., *Uganda's Sawlog Production Grant Scheme: a success story from Africa*. International Forestry Review, 2009. 11(1).

103. allAfrica.com. *34 held over destroying forests*. 02 April 2009 05 March 2010]; Available from: http://allafrica.com/stories/200904030249.html.

104. allAfrica.com. *Forestry officers cited in illegal timber sale*. 12 October 2007 05 March 2010]; Available from: http://allafrica.com/stories/200710111153.html.

105. New Vision Online. *17 pit-sawyers arrested*. 08 June 2006 05 March 2010]; Available from: http://www.newvision.co.ug/D/8/16/502893.

106. New Vision Online. *Bulisa RDC implicated in Budongo Forest logging*. 19 February 2007 05 March 2010]; Available from: http://www.newvision.co.ug/D/8/13/550036.

107. New Vision Online. *Trouble in the forests*. 30 October 2009 05 March 2010]; Available from: http://www.newvision.co.ug/D/8/12/699599.

108. New Vision Online. *Illegal pit-sawyers kill to forest offices*. 15 January 2009 05 March 2010]; Available from: http://www.newvision.co.ug/D/8/13/668226.

References continued

109. CIA. *The World Factbook*. 23 July 2009 12 November 2009]; Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/cg.html.

110. Sedjo, R. and D. Botkin, *Using forest plantations to spare natural forest*. Environment, 1997. 39(10).

111. Earth Policy Institute, *World forests continue to shrink*. 2006. Available from: http://www.earth-policy.org/index.php?/indicators/C56/.

112. Food and Agricultural Organization (FAO), *Responsible Management of Planted Forests: Voluntary Guidelines*. 2006. Available from: www.fao.org/forestry/site/10368/en.

113. Spellerberg, I.F. and J.W.D. Sawyer, *Standards for biodiversity: a proposal based on biodiversity standards for forest plantations Biodiversity and Conservation*, 1996. 5(4).

114. Food and Agricultural Organization (FAO), *Future production from forest plantations*. 2001. Available from: ftp://ftp.fao.org/docrep/fao/006/AC133E/AC133E00.pdf.

115. Cossalter, C. and C. Pye-Smith, *Fast-wood Forestry, Myths and Realities*. 2003, CIFOR. Available from: http://www.cifor.cgiar.org/Knowledge/Publications/Detail?pid=1257.

116. Timber Watch, *Potential Impacts of Tree Plantation Projects under the CDM: An African Case Study - interim report*. 2009. Available from: http://timberwatch.org/uploads/Draft%20Plantation_Projects_under%20CDM%20-%20Blessing%20&%20Wally(1).pdf.

117. Sinkswatch, *Problems with plantations*. Available from: http://www.sinkswatch.org/plants.html.

118. Carrere, R., *Plantations are not forests,* in *Watershed*. 2004. Available from: http://www.tiempocyberclimate.org/newswatch/comment041029.htm.

119. Sawlog Production Grant Scheme (SPGS). [cited 2009 11 December]; Available from: http://www.sawlog.ug/index.html.

120. Sunderlin, W., *Poverty and Forests*. 2007. Available from: http://www.rightsandresources.org/documents/files/doc_386.pdf.

121. Roux, J.-L., *Developing local community forestry management as a contribution to poverty reduction in the DRC*. 2008. Available from: http://www.chathamhouse.org.uk/files/11875_230608drc_agenda.pdf.

122. Tacconi, L., *Dentralisation, forests and livelihoods: Threory and narrative*. Global Environmental Change, 2007. 17: p. 338-348.

123. Ostrom, E., *Self-Governance and Forest Resources*. 1999, CIFOR: Bogor, Indonesia.

124. Sunderlin, W., J. Hatcher, and M. Liddle, *From Exclusion to Ownership? Challenges and Opportunities in Advancing Forest Tenure Reform*. 2008. Available from: http://www.rightsandresources.org/.

125. Mbile, P., et al., *Alternate Tenure and Enterprise Models in Cameroon: Community Forests in the Context of Community Rights and Forest Landscapes*. 2009, World Agroforestry Centre (ICRAF) and Rights and Resources Initiative. Available from: http://www.rightsandresources.org/documents/files/doc_1195.pdf.

126. Hazel, R., *Connecting community forests in the DRC with international markets: some initial ideas*. 2008, Forest Monitor.

127. Mukadasi, B. and L. Mulugo, *Multi-criteria assessment of community forestry program in Uganda*. The Social Sciences, 2008. 3(2).

128. Molnar, A., S. Scherr, and A. Khare, *Who Conserves the World's Forests? Community-Driven Strategies to Protect Forests and Respect Rights*. 2004. Available from: http://www.forest-trends.org/.

References continued

129. Forests Monitor, *Developing local community forestry management as a contribution to poverty reduction in the DRC*. 2008.

130. Macqueen, D., *Supporting Small Forest Enterprises: A Cross-Sectoral Review of Best Practice*. 2008. Available from: www.iied.org.

131. Molnar, A., et al., *Community-based forest enterprises: Their status and potential in tropical countries,* in *ITTO Technical Series*. 2007. Available from: http://www.rightsandresources.org/documents/files/doc_109.pdf.

132. Mayers, J. and S. Vermulen, *Company-community forestry partnerships: From raw deals to mutual gains?*, in Instruments for sustainable private sector forestry series. 2002. Available from: www.iied.org.

133. SNV. [cited 2009 12 December]; Available from: http://www.snvworld.org/en

134. Ostrom, E., *A general framwork for analysing sustainability of social-ecological systems*. Science, 2009. 325: p. 419-422.

135. Agrawal, A., *Common property institutions and sustainable governance of resources*. World Development, 2001. 29(10): p. 1649-1672.

136. Ostrom, E., M.A. Janssen, and J.M. Anderies, *Going beyond panaceas*. PNAS, 2007. 104(39): p. 15176-15178.

137. White, A., et al., *Seeing People Through the Trees: Scaling Up Efforts to Advance Rights and Address Poverty, Conflict and Climate Change*. 2008. Available from: www.rightsandresources.org.

138. Oyono, P., et al, *Improving Decentralised Forest Management in Cameroon: Options and Opportunities from Ten Years Experience*. 2007. Available from: http://www.cifor.cgiar.org/publications/pdf_files/govbrief/GovBrief0733E.pdf><http://www.cifor.cgiar.org/publications/pdf_files/govbrief/GovBrief0733E.pdf.

139. Centre pour l'Environnement et le Développement (CED). 26 November 2009]; Available from: http://www.cedcameroun.org/.

140. Friends of the Earth International. 16 March 2010]; Available from: http://www.foei.org/.

141. BR&D, RFUK, and CED, *Community payments for ecosystem services in the Congo Basin: design and pilot phase*. Project concept description. 2009.

142. Forests Monitor. *Developing community forestry in DRC*. 29 December 2009 12 March 2010]; Available from: http://www.forestsmonitor.org/en/community_forestry_drc.

143. Blomley, T., et al., *Seeing the wood for the trees: An assessment of the impact of participatory forest management on forest condition in Tanzania*. Oryx, 2008. 42(3): p. 380-391.

144. Government of Norway. *Supporting REDD to keep Tanzania green*. 06 March 2010]; Available from: http://www.norway.go.tz/News_and_events/News/News-from-the-Embassy/REDD_signing/.

145. Blomely, T. and H. Ramadhani, *Going to Scale with Participatory Forest Management: Early Lessons from Tanzania*. 2004, Tanzania Natural Resources Forum.

146. Mpingo Conservation and Development Initiative (MCDI). 24 June 2010]; Available from: www.mpingoconservation.org.

147. Fauna & Flora International. *A future for sustainable mpingo*. 07 May 2010 24 June 2010]; Available from: http://www.fauna-flora.org/news_mpingo2.php.

148. Nelson, F. and T. Blomley, *Peasants' forests and the king's game? Explaining institutional divergence in Tanzania's forestry and wildlife sectors,* in *Community Rights, Conservation and Contested Land: The Politics of Natural Resource Governance in Africa*, F. Nelson, Editor. 2009, Earthscan: London, UK.

149. Meshack, C., et al., T*ransaction costs of community-based forest management: empirical evidence from Tanzania*. African Journal of Ecology, 2006. 44: p. 468-477.

150. Persha, L. and T. Blomley, Management Decentralization and Montane Forest Conditions in Tanzania. Conservation Biology, 2009. 23(6): p. 1485-1496.

References continued

151. Zahabu, E., *Handei Village Forest Reserve, Tanzania,* in *Community Forest Management as a Carbon Mitigation Option*, D. Murdiyarso and M. Skutsch, Editors. 2006, Centre for International Forestry Research (CIFOR): Bagor, Indonesia.

152. Zahabu, E., *Kitulangalo Forest Area, Tanzania,* in *Community Forest Management as a Carbon Mitigation Option*, D. Murdiyarso and M. Skutsch, Editors. 2006, Centre for International Forestry Research: Bagor, Indonesia.

153. K:TGAL. [cited 2009 13 December]; Available from: http://www.communitycarbonforestry.org/.

154. Murdiyarso, D. and M. Skutsch, eds. *Community Forest Management as a Carbon Mitigation Option*. 2006, Centre for International Forestry Research (CIFOR): Bagor, Indonesia.

155. Skutsch, M. and E. Trines, *Operationalising reduced degradation within REDD*. 2006. Available from: www.communitycarbonforestry.org.

156. Skutsch, M. and L. Ba, *Crediting carbon in dry forests: the potential for community forest management in West Africa*. In press. Available from: www.communitycarbonforestry.org.

157. Chhatre, A. and A. Agrawal, *Trade-offs and synergies between carbon storage and livelihood benefits from forest commons.* PNAS, 2009. 106: p. 17667-17670.

158. Nelson, A. and K.M. Chomitz, *Protected Area Effectiveness in Reducing Tropical Deforestation: A Global Analysis of the Impact of Protection Status*. 2009, World Bank: Washington, D.C., USA. Available from: http://siteresources.worldbank.org/INTOED/Resources/protected_areas_eb.pdf.

159. The Economist. *The price of conservation: The unkindest cut*. 14 February 2008 30 November 2009]; Available from: http://www.economist.com/science/displaystory.cfm?story_id=10688618.

160. Mongabay.com. *Cameroon rainforest given 30 days to be conserved or sold off for logging*. 18 June 2009 30 November 2009]; Available from: http://news.mongabay.com/2009/0617-cameroon.html.

161. Global Environment Facility (GEF), *Project Identification Form: Conservation and Sustainable Use of the Ngoyla-Mintom Forest*. 2009. Available from: http://www.gefweb.org/uploadedFiles/Projects/Work_Programs/November_2009_Work_Program/BD_4084_CAMEROON_09-04-09%20CameroonSFM-%20PIF-9-3-09-Final.pdf.

162. Wildlife Works. 18 June 2010]; Available from: http://www.wildlifeworks.com/WWCarbon/WWCarbon/Welcome.html.

163. Karsenty, A., *Questioning rent for development swaps: new market-based instruments for biodiversity acquisition and the land-use issue in tropical countries.* Biodiversity Economics, 2007. 9(1).

164. Mongabay.com. *Carbon traders, not conservationists, could save Cameroon rainforest*. 15 February 2008 30 November 2009]; Available from: http://news.mongabay.com/2008/0215-cameroon.html.

165. Food and Agricultural Organization (FAO), *Carbon traders, not conservationists, could save the Cameroon rainforest*. Non-wood News, 2008. 17.

166. Gatti, J.R.J., et al., *The Biodiversity Bargaining Problem*. 2009, Biodiversity and Economics for Conservation, University College London. Available from: http://www.ucl.ac.uk/bioecon/11th_2009/Groom_1.pdf.

CHAPTER 5: AGRICULTURE AND FORESTS IN TROPICAL AFRICA

- Introduction
- The state of agriculture in tropical Africa
- Problems, challenges and future trends
- Interventions and responses

Courtesy of Bernard Pollack/ Nourishing the Planet