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PRODUCTIVE LANDSCAPES (PROLAND)

ASSESSMENT OF OPPORTUNITIES TO MINIMIZE FOREST LOSS THROUGH AGRICULTURAL INTENSIFICATION AND FOREST CONSERVATION IN THE DEMOCRATIC REPUBLIC OF CONGO (DRC)

APRIL 2016

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ACRONYMS AND ABBREVIATIONS

ACDI	Agricultural Cooperative Development International
ACP	Artisanal Cutting Permits
ADRA	Adventist Development and Relief Agency
AfricaLead	Africa Leadership Training and Capacity Building Program
ARCGIS	Aeronautical Reconnaissance Coverage Geographic Information System
ASTI	Agricultural Science and Technology Indicators
AWF	African Wildlife Foundation
CAADP	Comprehensive Africa Agriculture Development Program
CAMPFIRE	Communal Area Management Program for Indigenous Resources
CARPE	Central Africa Regional Program on the Environment
CBC	Community-Based Conservation
CBNFM	Community-Based Natural Forest Management
CBNRM	Community-Based Natural Resource Management
CBWM	Community-Based Wildlife Management
CCAFS	Climate Change, Agriculture, and Food Security
CGIAR	Consultative Group on International Agricultural Research
CIALCA	Consortium for Improving Agriculture-Based Livelihoods in Central Africa
CIAT	International Center for Tropical Agriculture
CIDA	Canadian International Development Agency
CIFOR	Center for International Forestry Research
CIRAD	*Centre de Coopération Internationale en Recherche Agronomique pour le Développement*
COMIFAC	*Commission des Forêts d'Afrique Centrale*
CRAA	*Centre de recherches agro-alimentaires* (Agri-Food Research Center)
DCVI	Department for Internal Supervision and Verification
DRC	Democratic Republic of the Congo
EMW&A	Emery Mukendi Wafwana & Associates
ERIN	Environmental Resources Information Network
EU	European Union
FACET	*Forêts d'Afrique Centrale Evaluées par Télédétection*
FAO	Food and Agriculture Organization
FAOSTAT	FAO Statistics
FCMC	Forest Carbon, Markets and Communities
FIB	*Fédération des Industriels du Bois*
FLEGT	Forest Law Enforcement, Governance, and Trade
FSC	Forest Stewardship Council
GBE	*Groupe Blattner Elwyn*
GDP	Gross Domestic Product
GDRC	Government of the DRC
GEF	Global Environment Facility
GFC	Global Forest Cover product

GFW	Global Forest Watch
GHG	Greenhouse gas
GIS	Geographic Information System
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
GPS	Global Positioning System
ha	Hectare
ICDP	Integrated conservation and development
ICRAF	World Agroforestry Center
IDIQ	Indefinite Delivery, Indefinite Quantity
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
IITA	International Institute of Tropical Agriculture
INERA	*Institut national pour l'Etude et la Recherche Agronomique*
IP	Implementing Partner
ITTO	International Tropical Timber Organization
IUCN	International Union for the Conservation of Nature
LiDAR	Light Detection and Ranging
LTRM	Land Tenure and Resource Management
LUP	Land Use Planning
kg	Kilogram
km	Kilometer
m^3	Cubic meter
MEDD	*Ministère de l'Environnent et Développement Durable*
Mg	Megagram
MT	Metric Ton
N/A	Not applicable
NASA	National Aeronautics and Space Administration
n.d.	No date
NEPAD	New Partnership for Africa's Development
NGO	Nongovernmental Organization
NTFP	Non-Timber Forest Products
NWP	Nature, Wealth, and Power
PA	Protected Area
PES	Payment for Ecosystem Services
PIRAM	Program in Maniema Province
PNIA	*Plan National d'Investissement Agricole.* National Agricultural Investment Plan
ProLand	Productive Landscapes
R&D	Research and Development
REDD+	Reducing Emissions from Deforestation and Forest Degradation (Plus)
REPLACE	Restoring the Environment through Prosperity, Livelihoods, and Conserving Ecosystems
RISE	Resources to Improve Food Security in Eastern Democratic Republic of the Congo
RSPO	Roundtable on Sustainable Palm Oil
RWE	Roundwood equivalents
SAR	Synthetic Aperture Radar
SCAM	*Société de Cultures et d'Industries Agricoles au Mayumbe*

SI	Sustainable Intensification
SODEFOR	*Société de Développement Forestier*
SOPACDI	*Solidarité Paysanne la Promotion de Actions Café et Développent Intégral*
TCG	Tree Cover Gain
TCL	Tree Cover Loss
Tg	Teragram
TOR	Terms of reference
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
USFS	United States Forest Service
USGS	United States Geological Survey
VOCA	Volunteers in Overseas Cooperative Assistance
WCS	Wildlife Conservation Society
WFP	World Food Program
WRI	World Resources Institute
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

In August 2015, United States Agency for International Development (USAID)/Washington requested that the Productive Landscapes (ProLand) team apply learning from the draft ProLand Sustainable Intensification (SI) Working Paper[1] to the context of development in the Democratic Republic of Congo (DRC), with special reference to the USAID Central Africa Regional Program on the Environment (CARPE) and USAID investment in the DRC at the strategic level. The ProLand SI Working Paper reviews research literature to provide USAID guidance on how to limit risks of extensification resulting from USAID efforts to intensify agriculture. The core questions of the final terms of reference (TOR) for the DRC assessment were:

- Where are forest and carbon stocks being lost most rapidly in the DRC?
- What are the overall drivers of this loss, and which are associated with agriculture?
- What are the impacts of different agricultural systems on forests and carbon stocks?
- Taking the country as a whole, what opportunities are there for USAID to promote agriculture in the DRC while minimizing impacts on forests?
- What approaches and practices can be scaled up?[2]

Team Leader Roy Hagen and ProLand staff member David Miller produced an assessment based on a literature review, remote sensing data, and interviews with experts and key informants in the United States and the DRC. In conjunction with the team's research, Tetra Tech contracted ProLand consortium member World Resources Institute (WRI) to produce a supplementary analysis of recent remote sensing data. Work began the last week of January 2016. Hagen and Miller spent February 6-26 in the DRC, where DRC national consultant Maxime Nzita joined them. Tetra Tech submitted an initial complete draft of the assessment to USAID on April 22, 2016.

Assessment approach: The assessment builds on the finding from contemporary research—as described in the ProLand SI Working Paper—that agricultural intensification increases pressure for, but does not necessarily result in, conversion of additional land to agricultural use. It examines efforts to intensify agriculture in the DRC, concentrating on four systems: swidden farming across the country, smallholder agriculture in Eastern DRC, recent intensive agriculture on the savanna, and large and small perennial crop cultivation on plantations and in Eastern DRC. The assessment describes implementation of approaches within each of these systems that may mitigate impacts of agricultural intensification on forests.

The assessment also builds on the finding in the ProLand SI Working Paper that prevention of extensification into forested lands requires accompaniment of agricultural intensification with incentives that impede forest clearing. Through a review of evidence, the assessment concludes that the institutions with the most promise of creating incentives to deter extensification in the DRC are those that increase benefits local communities derive from sustainable management of forests—and that success in this approach depends on willingness of communities to sustainably harvest the full range of timber and non-timber forest products (NTFPs) in order to generate sufficient profit to maintain institutions and deter forest clearing.

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1 "Sustainable Intensification Without Extensification? Limiting the Impacts of Agricultural Investments On Natural Lands"

2 While the key questions in the TOR do not include specific reference to the CARPE project, the importance of that project in the country necessitates a single focus for the project. Discussions with USAID, both in Washington and Kinshasa, reinforced this conclusion.

KEY FINDINGS

Deforestation and its causes. Available information does not allow complete understanding of distribution, rates, causes, and drivers of carbon and forest loss. We know that between 2000 and 2014, canopy cover on eight million hectares (ha) of the DRC dropped below 30 percent—the highest rate of rainforest loss among Central African countries (Global Forest Watch). Yet, while such accurate longitudinal data exists regarding tree cover loss (TCL), country-level information of similar quantitative accuracy regarding net changes in tree cover, forest degradation, or forest carbon emissions is not available. The dynamics of forest loss also remain poorly understood. Despite these knowledge gaps, the assessment draws a number of broad conclusions concerning forest loss in the DRC:

- Smallholder farmers, virtually all of whom practice swidden agriculture, are primarily responsible for deforestation. From 2000 to 2010, lands occupied by smallholder farmers practicing swidden agriculture increased by 46,182 ha, increasing from 12 percent to 13 percent of the country's total land area (Molinario et al., 2015). Distribution and rate of swidden expansion are influenced largely by subsistence demands associated with demographic factors, including both natural population growth and migration.
- Smallholder swidden agriculture has expanded most rapidly in fronts along population-dense rural zones, out from urban centers, and along transportation routes. By changing access to markets, improvements to the country's road network may pose the greatest single risk to forests in the near term.
- The other principal causes of deforestation are overcutting for wood fuels for urban markets and unsustainable timber harvesting. The formal industrial logging sector has shrunk considerably in recent years, and now harvests only one-thirteenth of the amount harvested by small-scale, almost totally unregulated, artisanal chainsaw millers. A major (yet unquantified) problem is fraudulent issue of artisanal cutting permits (ACPs) to companies of industrial capacity for uncontrolled harvest and export of saw timber.
- While large-scale commercial agriculture is an important potential cause of deforestation in the DRC, current expansion of it is inhibited by the following: requirement that only Congolese-majority-owned companies can receive concessions; a business climate characterized by widespread government corruption and a legal system unable to enforce contracts; and formidable land tenure constraints.

The development context. The national development context imposes substantial constraints on large-scale implementation of changes in agricultural and forest management systems described in this assessment. The country is recovering from conflict, and reestablishing and reforming its government; the government controls limited resources and remains vulnerable to corruption. Support for and large-scale implementation of sustainable agricultural intensification and forest management will be hindered by other national-level conditions that may reinforce or constrain positive change. Relevant constraints, discussed at greater length below, include outdated and poorly implemented policy and legislation regarding land and natural resources management; limited public- and private-sector investment in agriculture; an inhospitable business climate; and absence of public services and infrastructure across much of the country.

Challenges facing agricultural intensification with limited impact on forests. To meet its food security and economic needs, the DRC must dramatically increase agricultural output. Potential for success in this is evident, as the country contains over 20 million additional ha of non-forested land suitable for agriculture, and current yields of the most common farming system are well below yields obtained elsewhere. However, increasing yields within the DRC will require a radical transformation of current practice. Challenges differ depending on agricultural system. A limited number of areas in the country have population density and market systems critical to intensification of swidden agriculture. In areas where swidden farmers do adopt yield-raising inputs, they often do so at the expense of soil fertility, an indirect driver of deforestation. Tenure constraints limit regeneration of degraded plantations, while effective systems to manage expansion of cocoa

and coffee cultivation (which could occur in an intensive, environmentally friendly, sustainable manner) have not been put in place. The government has a program for enabling agriculture on underused, non-forested land, but this program targets capital-intensive agricultural systems, not smallholders.

Institutions and incentives that deter deforestation from agricultural intensification. Outside of protected areas, virtually no institutions limit the greatest drivers of forest loss in the DRC. Adding land into swidden systems by clearing forest currently generates value for smallholder farmers. Because of the country's vast size, inefficient transportation system, and limitations of government, community engagement is necessary to create the institutions necessary to change this circumstance. The DRC must transfer management of much of its forests to systems that benefit local communities. In the long run, this approach will require a socio-economic sea-change to empower local communities and increase their management rights—necessitating application of strategies regarding protected areas (PAs), industrial forest concessions, non-gazetted forest lands, and future community forest concessions. For this approach to succeed, communities must derive substantial benefits from sustainable management of forests and the range of forest products, including wood fuels, saw timber, wildlife, and NTFPs. Communities and forest-based enterprises will require training and capacity building. Appropriate changes in policies, regulations, and institutions will be necessary, along with strengthening and increased competitiveness of value chains.

The greatest opportunity to intensify agriculture and sequester carbon. The humid forests and savannas of the charcoal supply zones around urban centers present the greatest opportunities for intensive community forest management and intensification of smallholder agriculture.

The status of CARPE field activities.

- CARPE implementation partners have modestly invested in agriculture within the project landscapes, but effectiveness and widespread adoption of integrated soil fertility management practices are not fully evident.
- CARPE implementation partners have not developed systems to monitor and evaluate effects of their agricultural activities on forests. (Explanation for this deficiency may lie in the small size of current investments.)
- CARPE implementation partners have not yet demonstrated how their activities create incentives to reduce forest loss; no operational systems to incentivize communities to protect forests have been developed.

RECOMMENDATIONS FOR USAID AND THE DONOR COMMUNITY

To mitigate impacts on forests, projects designed to sustainably intensify agriculture in the DRC must situate and design investments appropriately. Based on report findings, agriculture investments may also require specific complementary actions to conserve nearby forest. The assessment recommends the following for creating a more balanced and integrated approach to increase agricultural productivity and reduce forest loss:

Take a landscape perspective in locating activities. Locations of any agricultural activities should be at a distance from unprotected forests. The appropriate distance will depend on the agricultural system and its potential to spread. In the long term, no distance may be "safe" without effective management of the country's forests. Locations for agricultural investments may be near forests only when effective means to protect against forest loss are in place.

For greatest effect, intensify production from agriculture and forests within areas of strongest market demand. Urban demand sustains prices and provides inputs necessary to drive smallholder agricultural intensification. Community forest management activities will be most successful where demands and prices for forest products (charcoal, timber, NTFPs, and bushmeat) are greatest. Urban demand for wood fuels in particular creates the conditions for development of community-based, multiple-use, intensive, natural forest management systems and agroforestry. Implementing partners (IPs) should target areas where forest-based, Community-Based Natural Resources Management (CBNRM) can be clearly profitable for communities, population pressure is greatest, and primary forests and PAs are at highest risk. Potential target areas include

southern Ituri, eastern Kahuzi-Biega, northern Virunga landscapes, and the interior of Lac Tele-Lac Tumba wherever significant forests remain outside of PAs.

Monitor impacts of agriculture on forests. If CARPE IPs intend to manage the relationship between agriculture and forests, they must monitor it. CARPE, with the larger development community, should establish baselines and monitor impacts of agricultural investments on factors critical to forest change, such as soil fertility, migration patterns, and provision of forest products through agroforestry. At the project level, ideally, this monitoring activity would be integrated into existing environmental and economic impact monitoring systems.

Increase understanding of landscape dynamics. Researchers in DRC must focus more directly on the relationship between agricultural growth and forest loss. To address agriculture's impact on forest loss, donors and government must support applied research aimed at filling knowledge gaps in this, in order to inform and guide government investments, donor program design, and project implementation. Gaps identified in this assessment include identification of hotspots of carbon emissions; agricultural suitability and potential, particularly of non-forested lands; direct causes (agricultural and otherwise) of deforestation and forest degradation; and geography and dynamics of charcoal value chains.

Plan and manage for the long term. The DRC will not overcome the barriers to intensive agricultural growth and sustainable forest management before the conclusion of CARPE III. Activities proposed by this assessment will likely require investments over the next two decades. Over that time period, USAID will necessarily change strategies, funding streams and mechanisms, and IPs. Achieving biodiversity and objectives pertaining to forest carbon and agriculture will require different approaches and activities. Flexible management mechanisms will be necessary to accomplish long-term goals. As project objectives, funding sources, and the development context change, USAID and CARPE IPs will have to apply adaptive learning to capture and implement lessons learned and maintain continuity in addressing stated priorities.

Collaborate to address fundamental constraints. The donor community must collaborate with civil society, the private sector, and the government to address the broader conditions that constrain sustainable agricultural intensification and forest management. As the economy improves, the population grows, the transportation infrastructure expands, and business investment returns, the "passive protection" now provided forests will diminish, and pressures on forests will mount dramatically. Specific issues to address should include decentralization of natural resource management and devolution of forest management rights and authority, effective operationalization of national land use planning, facilitation of forest-based enterprise development, reform of concession management, and allocations of ACPs. Moving forward on these issues will require policy dialogue, as well as development and refinement of approaches at the local level.

RECOMMENDATIONS REGARDING CARPE

Reconsider investment in agriculture. To date, CARPE partners have not invested heavily in agriculture. Given the challenges to sustainable intensification of swidden systems, and the difficulty of limiting impacts of agricultural investments on forests, CARPE management and IPs should consider revisions to their approach. Opportunities for agricultural investment identified in this assessment do not apply to all portions of all landscapes. Moreover, project resources must support implementation of approaches to pilot and refine community forest management (rendered easier by the new law supporting community forest concessions). We recommend that CARPE support agriculture only where community forests already have been put under sustainable community forest and natural resource management—and scale up only approaches demonstrated to maintain soil fertility over time.

Build teams with expertise and motivation to undertake CBNRM, and where relevant, agriculture. Development of commercially oriented CBNRM systems that generate revenues and new benefits will require mobilization of people with significant experience and expertise in these areas. This development requires expertise in skill sets, including 1) development of strong capacities for good governance, transparency,

safeguards, and self-enforcement; 2) technical aspects of agriculture and natural resource management planning and implementation; 3) financial and economic analysis, strengthening of value chains, processing and marketing, and targeted assistance for natural resource-based enterprise development; and 4) self-financing and participatory monitoring of community management systems.

Take advantage of the new community forestry law. CARPE partners should aggressively take advantage of the new law. They should begin piloting approaches to sustainable community management of forests in different ecological and socio-economic contexts—targeting development of the most economically and environmentally sustainable models of CBNRM in different community forest settings, and co-management of different logging concessions and protected areas.

1.0 INTRODUCTION

1.1 BACKGROUND TO THE ASSESSMENT

The Productive Landscapes (ProLand) project is a Restoring the Environment through Prosperity, Livelihoods and Conserving Ecosystems (REPLACE) Task Order funded by the United States Agency for International Development (USAID). The project aims to develop evidence and tools that demonstrate how multiple gains can result from integration of activities to promote agricultural intensification of land use (producing more per unit of area) with environmental management, economic development, and best management practices of governance. These gains could include increased food production, reduced biodiversity loss, reduced greenhouse gas (GHG) emissions, enhanced adaptation to climate change, and strong broad-based economic growth. The aims of this project go beyond a focus exclusively on increasing agricultural production through improved provisioning of agricultural inputs, strengthening of targeted value chains, and other interventions by increasing attention to measures that would address root causes of land degradation and reduce risks of "extensification" or conversion of more natural lands to agricultural land.

In line with this scope of work, USAID tasked the ProLand team with a literature review to provide evidence and guidance to USAID on how to limit risks of extensification resulting from USAID efforts to intensify agriculture. The result was the ProLand Sustainable Intensification (SI) Working Paper "Sustainable Intensification Without Extensification? Limiting the Impacts of Agricultural Investments on Natural Lands." This global review draws on scientific and development literature to: 1) summarize an ongoing debate on the relationship between sustainable intensification and conversion of natural lands; 2) highlight nine common technical approaches that can help reduce pressures to convert natural lands, while providing evidence of how these same methods may also increase land conversion; 3) summarize additional efforts to reduce conversion of natural lands via incentive mechanisms and multi-institutional planning and policy.

After review of the first draft of the ProLand SI Working Paper, in August 2015, USAID/Washington asked the ProLand team to apply learnings from the ProLand SI Working Paper to the context of development in the Democratic Republic of Congo (DRC), with special references to the USAID Central Africa Regional Program on the Environment (CARPE) project and USAID investment in the DRC at the strategic level. (Annex C includes the Terms of Reference [TOR) for this assignment.) The resulting strategic assessment, conveyed in this document, evaluates the context of agricultural development and forest conservation in the DRC, and describes factors to consider when designing investments to support sustainable agricultural intensification in a manner that would alter land use while reducing forest loss and GHG emissions. Key questions addressed in the assessment are:

- Where are forest and carbon stocks being lost most rapidly in the DRC?
- What are the overall drivers of this loss, and which are associated with agriculture?
- What are the impacts of different agricultural systems on forests and carbon stocks?
- Taking the country as a whole, what opportunities are there for USAID to promote agriculture in the DRC while minimizing impacts on forests?
- What approaches and practices can be scaled up?

1.2 TIMELINE AND METHODS

To produce this report, Tetra Tech mobilized a three-member team consisting of Team Leader Roy Hagen, ProLand staff member David Miller, and DRC national consultant Maxime Nzita to produce an assessment based on a review of literature and remote sensing data, and interviews with experts and key informants in the

United States and the DRC. In conjunction with the team's research, Tetra Tech contracted ProLand consortium member World Resources Institute (WRI) to produce a supplementary study assembling relevant findings from recent remote sensing data. TOR for that study are in Annex D.

Hagen and Miller spent the last week of January and the first week of February reviewing literature and conducting interviews. An initial meeting introduced WRI and UMD staff to the most current and most relevant remote sensing analyses of forest loss in DRC. Hagen and Miller joined Nzita in the DRC on February 6, and returned on February 26. In the DRC, the team interviewed USAID staff, representatives of the Government of the DRC (GDRC) (the *Primature*, the Ministries of Agriculture and Environment), staff of CARPE nongovernmental organization (NGO) implementing partners (IPs), donor organization staff, agricultural experts, and representatives of civil society organizations (for a full list, see Annex B). Hagen and Miller also joined USAID and United States Forest Service (USFS) staff from February 18 to 21 on a visit to the Africa Wildlife Foundation (AWF) center of operations and sites around the small city of Djoula within the USAID-supported Moringa-Lopori-Womba Landscape. After returning to the United States, Miller and Hagen continued interviews and their review of literature. On March 18, they presented preliminary findings to USAID/Washington staff via phone. Tetra Tech submitted an initial complete draft of the assessment to USAID on April 22, 2016.

1.3 PRESENTATION OF THE DOCUMENT

Directly following this introduction, Chapter 2.0 presents the principles of previous ProLand research that guided the assessment conveyed in this document, including strategies for reducing impacts of agricultural intensification and strengthening sustainable forest management. Chapter 3.0 then sets the context for the assessment by overviewing current knowledge regarding drivers, distribution, rate, causes, and context of forest loss in the DRC. The chapter also describes limits to that knowledge. Chapter 4.0 addresses agriculture and forestry in DRC separately. Chapter 4.0 first presents the status, potential, and challenges to land-intensive agriculture at the country level, and then applies the strategies identified in Chapter 2.0 to detailed discussions of potential for land-intensive agriculture in four dominant systems: swidden agriculture, smallholder agriculture in eastern DRC, intensive savanna agriculture, and perennial crop systems. This section of Chapter 4.0 concludes by discussing the role of agriculture in the National Reducing Emissions from Deforestation and Forest Degradation (Plus) (REDD+) Strategy. Chapter 4.0 then turns to the forestry sector, presenting available information about industrial and artisanal logging, and wood fuel production. Both the agricultural and forestry sections of Chapter 4.0 offer strategic options for limiting deforestation and forest degradation, emphasizing impacts of agriculture. Chapter 4.0 concludes with a review of forest management in the National REDD+ Strategy. Chapter 5.0 applies the strategies identified in Chapter 2.0 to recent and ongoing donor-funded projects whose objectives include agricultural intensification and/or sustainable forest management. Chapter 6.0 presents conclusions of the assessment, followed by general recommendations and recommendations specific to the CARPE project.

2.0 ASSESSMENT FRAMEWORK

2.1 CONTEXT

The approach of this assessment draws on findings of the draft ProLand paper titled "Sustainable Intensification without Extensification?" This global review of scientific and development literature summarizes an ongoing debate on the relationship between agricultural intensification and loss of natural lands, with focus on forested lands. It highlights nine common technical approaches that can help mitigate conversion of natural lands to agriculture, while providing evidence of contexts in which these same methods may increase land conversion. The ProLand SI Working Paper also summarizes incentive mechanisms and multi-institutional planning and policy approaches that can be used in conjunction with the nine technical approaches to forestall impacts of agricultural intensification on forest and other natural lands.

The assessment also draws on the ProLand SI Working Paper to consider these same issues in the context of the DRC. Two conclusions from the ProLand review of research literature have proven to be fundamentally important:

1) Agricultural intensification increases pressure for, but does not necessarily result in, conversion of additional land to agriculture by increasing value of cropland relative to forest land. This occurs principally in two ways:

    - Agricultural intensification based on use of higher-yield technologies increases value of agricultural land relative to that of natural lands by rendering agriculture more productive, and hence more profitable. New technologies thus increase incentives to expand production into currently unfarmed areas. Despite producing more crop per ha, agricultural intensification often stimulates both existing and potentially in-migrant farmers to extend production onto new land.
    - At a large enough scale, producing more food per unit of land may also result in lower prices and thus stimulate latent (possibly export) demand for the crop produced, thus driving farmers to clear more land to cultivate that crop (Angelsen and Kaimowitz, 2001; Byerlee et al., 2014).

2) Following logically from 1), agricultural intensification on forest margins leads to ongoing conversion of land unless incentives change.

In the tropics, many people have perceived natural forest lands as idle and ready for productive use. To counterbalance increased incentives to clear forest land requires countervailing measures to motivate those who would otherwise convert forest to cropland. Agricultural intensification without extensification can be accomplished only by application of an integrated approach promoting both production efficiencies and conservation incentives. To address these two halves of the equation, this assessment explores means to intensify agriculture in a manner minimizing pressure to clear forest. It also explores ways to manage forest resources in the DRC sustainably to benefit local communities. Achieving this balance requires more than technical innovation, improved forest management, and community organization. It necessitates strategic action coordinated at multiple scales across and beyond the agriculture and forestry sectors, reform that provokes policies and actions empowering men and women of rural communities, and improves returns and reduces risk from investments in small-scale agriculture on their lands and in resources of their forests.

2.2 FRAMEWORK USED IN ASSESSMENT OF AGRICULTURAL INTENSIFICATION

In this assessment of agricultural intensification, we draw upon seven of the nine technical approaches presented in the ProLand SI Working Paper[3]. We can group these approaches according to the concepts of land "sparing" and land "sharing." As explained in the ProLand SI Working Paper, intensification on land dedicated exclusively to agricultural use has been called "land sparing," because it reduces the amount of land necessary to produce a given amount of food or fiber. At a global scale, intensification of agriculture has "spared" millions of square miles of land from conversion that would have been necessary had all agriculture been land-extensive. In the land sharing approach, crops are cultivated in systems of higher or mixed biodiversity. This has been called "sharing" because it refers to agriculture where crops grow on land with natural vegetation and animal life, where biodiversity is retained or reintroduced. Such systems may also reduce the harvesting of ecosystem products from natural landscapes.

Table 1 lists the five technical approaches and associated principles from the ProLand SI Working Paper used in this assessment. We do not assume that these approaches necessarily work in any particular context, but use them to guide analyses of factors and issues of potential importance. Because this assessment was partially conceived as a case study for the ProLand SI Working Paper, it draws on available evidence to describe how each approach has been or may be applied, and, to the extent possible, assesses effectiveness of its associated principle in the DRC. In addition to listing the ProLand SI Working Paper approaches and principles, Table 1 also lists agricultural systems in the DRC to which each principle is most relevant.

Table 1. Technical Approaches to Agricultural Intensification Discussed in the Assessment

Approach	Principle	System where discussed
Intensify agriculture away from forests and natural lands	Targeting agricultural investments away from forests and natural lands reduces likelihood of land conversions and associated negative environmental impacts.[4]	Agriculture on the savanna, in deforested zones around urban centers, and in eastern DRC.
Substitute agricultural inputs for fallowing	Using more labor, fertilizer, and water intensifies use of land already converted to agriculture, thus reducing pressure on natural lands.	Smallholder swidden, both in remote forests and near urban centers.
Revitalize degraded and low productivity lands	Intensifying crop and livestock production on degraded land unlikely to revert to forest or other natural conditions can reduce need to convert additional forested lands.	Abandoned and underused plantations and savanna.
Introduce trees in farms: agroforestry	Cultivating trees on farms and pastures raises yields and produces a variety of goods and services, including fuelwood.	Charcoal supply zones of urban centers.
Cultivate tree monocrops	Intensifying cultivation of tropical perennials increases efficiencies and resilience of cultivated land, thus sparing natural lands.	Palm oil and rubber plantations; abandoned plantations.
Cultivate tree crops within diverse forests	Improving performance of tree crops within forests and with other trees "shares" land and reduces negative environmental impacts.	In cocoa and coffee systems, particularly in Eastern Congo.
Diversify goods and services from forests	Increasing yields of timber and non-timber forest products and other services increases profitability of natural lands to better compete with agriculture.	The Forestry Sector, Community-Based Natural Resource Management (CBNRM), and Community-Based Natural Forest Management (CBNFM).

[3] The two approaches not discussed at length in this assessment relate to monocrops and diversification through introduction of livestock. While each of these occurs currently in the DRC, neither is a large activity or presents a great opportunity in the short term to reduce impacts on forest.

[4] How far away depends on the agricultural system involved, its potential to expand, and the timeframe considered. Agricultural systems that require irrigation are less likely to spread. For successful intensification, a safe distance today may be too close within a decade.

2.3 APPROACH USED FOR ASSESS FOREST CONSERVATION AND MANAGEMENT

This assessment accepts the conclusion of the ProLand SI Working Paper that increased pressure on forests induced by agricultural intensification will result in forest loss unless an effective counterbalance emerges. One of the nine principles proposed in the ProLand SI Working Paper states that "*Increasing the yields of timber and non-timber forest products and other services increases profitability of natural lands to better compete with agriculture."* Of course, for this approach to be effective, the profit generated cannot go to just anyone, but must be gained by those who would otherwise clear the forest for agriculture. In the context of DRC, this means that the forest must be rendered more profitable to the smallholder farmers who would otherwise clear the forest for their swidden croplands.

A more detailed discussion of this principle, only briefly presented in the ProLand SI Working paper, is necessary to explain and justify the approach of this assessment. It starts with community-based conservation (CBC), which emerged to address some shortcomings of the "fines and fences" approaches to conservation. One theory was that successful conservation of important biodiverse areas necessitated participation (co-management of those areas) by communities. A popular form of CBC was "integrated conservation and development projects" (ICDP). ICDPs sought to link biodiversity conservation with economic development through development of diverse economic activities like bee keeping, livestock husbandry, soap making, or even agricultural intensification, as alternatives to unsustainable forest uses (Newmark & Hough, 2000). One main assumption was that by providing alternative income generating activities, ICDPs reduce need to exploit forest (McShane and Newby, 2004). Experience revealed, however, that introduction of economic alternatives does not necessarily create direct incentives for forest conservation. Profitability of alternative income generating activities may or may not lead to sustainable use and improved management of forests. Some activities (for example, provision of sewing machines and training of tailors, or assistance in raising chickens) may help generate additional income, but do not offer additional incentives to the community to invest in forest conservation and improved forest management. Also, viability and long-term success of new, alternative activities to generate income generally depend on access to markets, assistance with enterprise development, and other factors. Moreover, ICDPs generally did not address underlying issues of insecure resource rights and land tenure, as well as failures in environmental governance and related drivers of deforestation. ICDPs rarely enabled communities to control uses of their natural resources (Kiss, 1990). Consequently, these early steps away from the "fines and fences" approach often did not successfully link development and conservation activities, frequently resulting in continued degradation of forest resources (Adams et al., 2004; Roe, 2008). In spite of these experiences, donors and IPs continue to promote as a conservation strategy provision of technical assistance and financial support for activities that generate alternative income.

Some instances of CBC in the form of community-based natural resource management (CBNRM) directly link conservation and development by establishing systems to generate substantial benefits and revenues for communities by empowering them to manage forests and natural resources. CBNRM differs from ICDP by giving communities much greater control over management and benefits of natural resources. Not all CBNRM initiatives have been successful. Proper enabling conditions, such as an appropriate legal framework, are critical to long-term success of CBNRM efforts. CBNRM depends on transfer of management responsibility to communities by the government. Communities must also be allowed to enjoy financial benefits of this management. Governments, NGOs, and donors often emphasize non-commercial uses of forests and natural resources, but long-term success requires that communities receive financial benefits to compensate for often underappreciated management costs. A 2013 assessment of 20 Kenyan participatory forest management projects that forbade communities to cut trees for commercial purposes found no significant increases in benefits to communities and no verifiable change in forest management (Kenya Forest Working Group, 2013).

A number of CBNRM initiatives have functioned successfully for decades in Africa. These have demonstrated that mobilized communities can play an important role in slowing or halting deforestation. Through these initiatives, communities have shifted to sustainable modes of natural resource use through adoption of improved management practices that generate significant socio-economic benefits for community members in tandem with benefits to the environment. As a group, these initiatives provide lessons to guide designs of similar activities. One lesson is that success of the approach depends on generation of substantial benefits to communities and their members through commercialization of natural resources.

Five community-based dryland forest management programs in Sahelian West Africa began over 30 years ago and are now operational in Burkina Faso, Mali, Senegal, Gambia, and Guinea. The core of each of these is production of wood fuels for urban markets. In replacing deforestation with sustainable production, they have helped stabilize land use and ensure long-term productivity of forests, additionally benefitting the climate and the environment. The local institutions are designed such that the individuals who cut the most fuel wood or produce the most charcoal receive the greatest revenues—benefits are proportional to efforts by the individual. This approach assures that the largest share of revenues goes directly to households, rather than the local government or community leaders. In fact, some communities in Senegal earn approximately one million US dollars annually from charcoal sales from wooded savanna forests (John Heermans, personal communication). Such self-financing forms of CBNRM also usually include a process to reinvest a portion of revenues back into management costs. These may include patrolling, payments for support services, maintenance of access roads and trails, assisted regeneration, etc. (Hagen, 2014). For example, support for community-based forest management and sustainable charcoal production has been a key feature of USAID program assistance in eastern Senegal. From 2003 to 2014, USAID funded the Wula Nafaa program in one of the poorest areas of the country, also home to the largest remaining areas of natural forest under pressure from non-sustainable harvesting and conversion to cropland. Wula Nafaa supported an approach based on the principles of the "Nature Wealth Power" framework, which integrated attention to biophysical, economic and governance dimensions of CBNRM. The project improved governance of natural resources, including forests; produced multiple additional environmental benefits; and resulted in dramatic and broad-based reduction in poverty (USAID, 2014).

Another success story also began about 30 years ago in Zimbabwe. The USAID-funded Communal Area Management Program for Indigenous Resources (CAMPFIRE) project was conceived as a local government-based wildlife management activity in which communities would receive a share of revenues from trophy hunting and related ecotourism activities. USAID and other donors then funded successful adoption of the approach in Botswana and Namibia, where it evolved into community-based wildlife management. USAID investment in Namibia over the 15-year period from 1992 to 2008 (see the case study in USAID 2013). As a result of those investments, poaching was effectively controlled, and wildlife populations increased substantially. At the same time, non-cash benefits and income from ecotourism and related CBNRM activities increased dramatically from less than 1 million Namibian dollars in 1994 to almost 50 million in 2011. Additional positive social impacts and beneficial impacts on food security, climate change, and biodiversity and ecosystem services have also been documented (USAID, 2013). Nearly all revenues come from joint ventures with private ecotourism and trophy hunting companies, and go directly to the community management structure. Evaluation of this program leads to the conclusion that implementing organizations must take care to establish very competent and reliable community-level institutions to ensure that the bulk of revenues goes directly to the community management body rather than households. The Namibia program also includes a small component of community bushmeat production and marketing. While successful establishment of these examples of CBNRM took decades, the alternatives look less promising in the DRC. Other than CBNRM, payments for ecosystem services (PES) approaches have also been used to generate revenues for communities to encourage them to protect forests. In PES schemes, users and beneficiaries of the ecosystem service(s) reimburse communities for maintaining or improving those services. Examples of ecosystem services in PES schemes include fresh water, timber, climate regulation, recreation, and aesthetic values (WRI, 2008). International markets have emerged for a variety of ecosystem services, including carbon, water, biodiversity and other globally and locally valued benefits.

For forest carbon, PES takes the form of REDD+ programs based on carbon credits. However, despite significant investments and great expectations, global carbon markets remain voluntary and rather small. Long delays and uncertainty with carbon markets have led many REDD+ programs to turn to other strategies for forest conservation. In DRC, REDD+ currently is key to government and donor strategies to regulate deforestation and carbon emissions. Despite the overwhelming challenges faced by other efforts in Africa to create large-scale carbon payment schemes (Mbow, C. et al., 2012), donors and the government have invested heavily in REDD+ and carbon payments. Unfortunately, even if carbon markets do become widely available globally, weaknesses in national and local governance in DRC present major barriers both to the program generally, and to successful provision of benefits to community members. The national government has limited capacity to implement REDD+ policies and programs (Aquino and Guay, 2013), and the level of corruption at this level, if not managed, could be crippling (Assembe-Mvondo, 2015). At the local level, carbon credit schemes generate revenues for the community as a whole. This creates important challenges to the equitable distribution of the funds to individuals. In the pilot REDD+ communities visited by Pollini (2014), funds did not reach the household level, but were managed by committees and associations rarely elected, not always representative, and often controlled by local elites.[5]

Promotion of ecotourism is another approach applied to provide incentives to communities to protect their forests (Stem. et al, 2003). Often, but not always, organized as a PES program, factors in DRC limit viability and scalability of ecotourism as an approach to provide economic returns to local populations and to counterbalance pressures to expand agricultural lands. The dense, humid forests of the Congo Basin render game viewing very difficult, unlike in southern and eastern African countries where ecosystems of grassland, savannah, shrub lands, or desert allow easy viewing of large mammals, and where wildlife tourism has been most successful (Sayre et al., 2013). This constraint on visibility limits tourism potential in DRC except under special conditions, such as observations of habituated mountain gorillas—but even tourist areas with gorillas such as the Dzanga-Sangha Primate Habituation Program in the Congo Basin's enormous Sangha Tri-national Park receive a limited number of visitors (1,342 from 2001-2006) (Wikipedia, 2016). Revenues from an estimated 268 tourists a year are not enough to cover operational costs, let alone management of protected area or revenue sharing with communities. Poor transportation infrastructure and high levels of insecurity in DRC also significantly hinder attraction of large numbers of tourists. Compared to CBNRM schemes that tap into existing markets, PES programs required to establish new markets—whether for forest carbon or ecotourism—face serious constraints in providing incentives to community members to manage their forests sustainably in DRC.

The two subsets of CBNRM, community-based natural forest management (CBNFM) and community-based wildlife management (CBWM) also empower community institutions to sustainably manage forest resources. Like CBNRM more generally, they depend upon local governance systems with representative forest management structures and a process for equitable sharing of costs and benefits. CBNFM almost invariably requires development of simplified forest management plans that balance offtake with regrowth. To counterbalance harvesting, plans may include assisted regeneration, reforestation, and other management interventions in addition to natural regeneration. CBNFM initiatives usually establish contracts to empower communities and define their rights and responsibilities. Among their responsibilities, typically, is obligation to prevent conversion of community forest land into agriculture. CBNRM has also been applied successfully to increase conservation benefits through community management of resources in buffer zones and extractive reserves (Brooks et al. 2006). CBNFM is also compatible with REDD+ activities. When carbon markets gain momentum, communities managing natural resources will be well-placed because of their organization, their technical skills in resource management, and their experience developing and reinforcing rules governing resource access and use.

[5] As noted by Pollini, local capture of project funds is not unique to REDD+ programs, and has been a weakness of many CBNRM efforts. This is why this assessment recommends organizing schemes in a manner providing direct payment to individuals.

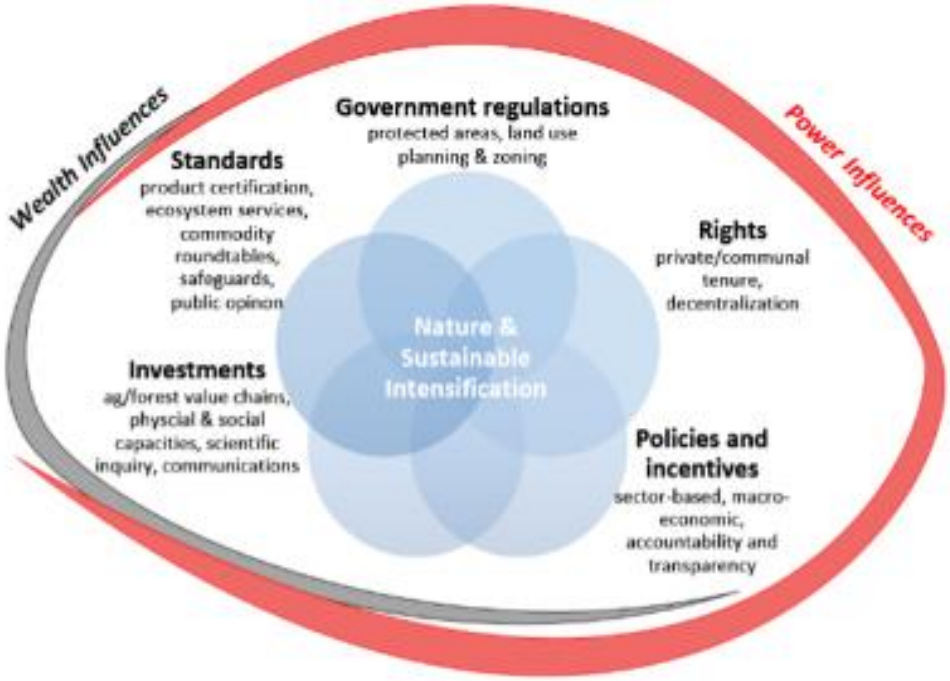
The potential of CBNRM is largely untested in the Congo Basin and DRC. In fact, although the approach has been piloted in DRC, no legal framework allowed for CBNRM until February 2016. The CARPE Phase II Evaluation conducted in 2010 included a set of principles for successful CBNRM (listed in Table 2), recommended for use by CARPE partners (ECODIT, 2010). This assessment applies these principles to the status of forest-based CBNRM in the DRC, and use of CBNRM or other approaches to increase the value of forests to communities in the National Strategy for REDD+ and in the CARPE Program. These principles then form the basis of the assessment's conclusions and recommendations regarding how, in conjunction with agricultural intensification or independently, incentives can be created to minimize forest loss and sequester significant amounts of carbon by bringing severely degraded forest lands under community management.

Table 2. Basic Principles of CBNRM from the CARPE Phase II Evaluation (ECODIT, 2010)

1. Participation in CBNRM should be voluntary and not imposed from outside.
2. The community should define itself, whether a single village or a group of villages or perhaps a lineage within a village.
3. The community should create an institutional structure that represents all members and subgroups of the community, not just a particular user group.
4. The community should negotiate clearly defined, agreed borders/limits to the lands/resources it wants to manage—usually in accordance with traditional land tenure/resource rights.
5. The community should commit to sustainable use of its natural resources to ensure adequate regeneration of resources it harvests/uses commercially and for subsistence. (Development of systems/techniques for ensuring sustainable use often comes later.)
6. The community management structure must be empowered (by formal government structures and policies at local and national levels) with exclusive rights to control access, manage resources, and harvest and market resource-based products from the lands/waters the community will manage.
7. Rights and obligations of each party (community and government services) should be clearly defined.
8. Empowerment of the community should be conditional. Along with guarantee that the community can continue to exercise its rights as long as it respects its new obligations (such as ceasing to hunt protected wildlife species) should be recognition that the community's rights can be suspended or nullified if it does not live up to its obligations.
9. The community should have a plan for equitable (fair) sharing of costs of CBNRM and benefits derived from CBNRM.
10. Community managers should establish a system of sustainable financing whereby some revenues generated from marketing natural resource-based products are reinvested into management of the resources (i.e., creation of a management fund). CBNRM is generally much more sustainable with reliance on paid, rather than voluntary, workers.
11. The community must develop a set of agreed-upon rules or a management plan governing access and use of the natural resources that it manages.
12. Under CBNRM, community managers rather than government agents become responsible for enforcing the rules governing access to and use of natural resources within the community. The community will frequently need assistance from local authorities/government agents in dealing with people from outside the community.
13. Systems should be established, respectively, for monitoring abundance/regeneration and off-take of each marketable resource, and for adjusting off-take to ensure that this does not exceed regeneration of the resource.

2.4 FITTING THE ASSESSMENT INTO THE LARGER CONTEXT: NATURE WEALTH AND POWER

Figure 2.1. Nature, Wealth, and Power (NWP), and Sustainable Intensification



USAID has requested that this assessment principally inform USAID/DRC strategic planning across the next five to ten years. For that reason, it focuses on relatively short-term, geographically specific actions. The analysis nevertheless considers the larger context by drawing on USAID's Nature, Wealth, and Power (NWP) framework, as adapted in the ProLand SI Working Paper. Figure 2.1, taken from that paper, shows elements of this approach, underscoring socio-cultural and politico-economic changes needed to stimulate and enable a broad movement away from land use associated with high levels of GHG emissions and toward patterns of land use and improved management of natural resources. This is part of an integrated landscape approach that generates increased economic benefits for local communities while ensuring ecosystem health and reduced levels of GHG emissions. In this assessment of opportunities and constraints in the DRC, our analysis of shorter-term options also identifies broader constraints in these elements of the NWP framework. While underscoring their critical importance, it does not, however address them in depth. It is nevertheless clear that large-scale sustainable agricultural growth and forest conservation will require transformational change in the country's governance and economic structures in ways that empower communities to sustainably manage the natural resources upon which they depend.

3.0 DRIVERS OF DEFORESTATION

3.1 OVERVIEW OF FOREST AND CARBON LOSS

The remote sensing products developed for this report employ the most current data and apply the most advanced methods for assessing forest loss and associated carbon emissions. However, limitations in available data are evident in a number of ways, perhaps most importantly in those data supporting estimation of changes in carbon stocks resulting from forest loss and regrowth. Remote sensing data currently allow accurate assessments of neither impacts of swidden agriculture nor effects of fuel wood harvesting outside of dense forests in the DRC. Improvement of estimates awaits acquisition of data over longer time periods that will lead to better understanding of cycles of fallow regrowth, and more fieldwork will be necessary to causes of forest loss more incisively. Until then, we present these products as indicative and preliminary, and explain limits of the analysis where appropriate.

3.1.1 SPATIAL ANALYSIS OF FOREST LOSS

The DRC has the highest rate of rainforest loss among Central African countries. According to the WRI Global Forest Watch, 200 million ha, or 87 percent of the country, had a canopy density exceeding 30 percent in 2000. By 2014, almost 8 million of those ha, or 4 percent, had dropped below the 30 percent threshold. This compares with drops of 1.1 percent in Gabon, 2.0 percent in Cameroon, and 1.5 percent in the Republic of Congo over the same period of time. On the whole, TCL rates in the countries of the Congo Basin are among the lowest of the major tropical rainforest zones of the world. By comparison (over this same period, and measured in the same way), Indonesia, Nicaragua, and Côte d'Ivoire all lost about 11 percent of their forest cover (de Wasseige, et al., 2014; Global Forest Watch).

To understand what these calculations of TCL reveal about forest loss[6] in the DRC requires an explanation of their generation and proper interpretation. The US government has significantly invested in use of remote sensing to describe changes in forest cover in the DRC. In the most recent collaborative effort, the University of Maryland, Google, the United States Geological Survey (USGS), and the National Aeronautics and Space Administration (NASA) have produced maps of tree cover gain (TCG)/TCL based on the Global Forest Cover product (GFC)—a global, yearly, 30-meter-resolution forest cover, loss, and regrowth product. Map G-1, produced by WRI for this study, shows TCL within the period 2000-2014 based on this work.[7] The map indicates high rates of TCL in Bas Congo, around Kinshasa and Kanaga, and along the country's eastern border. A lattice of TCL covers the more densely forested sections of the country, while TCL is more diffuse in the dryer southeastern portion of the country. This distribution reflects associations of deforestation with transportation networks and with areas of high population density—both discussed later in this assessment.

Map G-2, also produced by WRI for this study, shows a similar distribution of TCG. However, as more incisive definitions of TLC and TLG will help explain, the two maps are not comparable. The extraordinary spatial and spectral resolution of imagery used to produce these maps allows detection, under certain circumstances, of the selective harvest of individual large trees in industrial logging concessions. However,

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[6] In this assessment, we use the term "forest loss" to refer to both deforestation and forest degradation.

[7] The online interactive Forest Atlas of Democratic Republic of Congo (http://www.wri.org/our-work/project/congo-basin-forests/democratic-republic-congo#project-tabs) is an Atlas that includes tree cover loss and tree cover gain layers based on the same data underlying the maps in this assessment. The Atlas is managed by the DRC Ministry of the Environment & Sustainable Development with the support of WRI.

significant limitations to use of these maps for explaining forest loss in the DRC are evident. Analysis of satellite imagery allows identification of areas of pronounced drops in canopy cover, together identified as TLC on the maps. This means that classification of an area as having lost cover does not equate with total loss of trees, as that area has not necessarily been cleared in its entirety (fields, for example). Nor does the method of remote sensing analysis applied to generate these maps capture all types of forest loss. It is less likely to detect forest degradation activities that do not result in a pronounced drop in canopy cover, such as selective or partial harvesting of forests for saw timber or wood fuels around cities. Further, much of the historical imagery is coarse by comparison to that currently available. Analysis of imagery from Landsat 8, which came online in January of 2013 and has much greater spectral resolution than its predecessor, suggests that earlier analysis may have underestimated tree cover loss in DRC by up to 65 percent (Tyukavina et al, 2015). The new satellites are now able to identify changes in canopy cover previously undetected.

Even greater limitations exist in the ability of remote sensing to record TCG. In creating Map G-2, TCG was defined as achievement of canopy density with 50 percent or more of trees over 5 meters high at any time between 2000 and 2012. Gradual changes are more difficult to capture and accurately categorize than TCL, as TCL usually occurs suddenly, while forest recovery thereafter is gradual, if this occurs. Indeed, accurate measurement of TCG may require analysis of the appropriate imagery covering a time period of more than 20 years (Annex G). Thus, because data and imagery used to map TCL and TCG involve different measurements with different levels of accuracy, these cannot be used together to determine net changes in forest cover.

Improvements in technology and analysis of remote sensing imagery are unlikely to breach the gap between detection and explanation of changes. Despite our ability to correlate locations of deforestation with contextual factors (commercial concessions, protected areas, demographics), determination of direct causes of forest loss in most cases still requires acquisition of complementary field data (Annex G). One partial exception to this statement is smallholder agriculture in the DRC because of its unique footprint. Recent research has yielded insight into this cause of deforestation. Swidden agriculture, uncontestably the dominant form of agriculture and arguably the most common cause of deforestation, creates a distinctive pattern of fields, fallow areas, and secondary forest. Molinario et al. have mapped change in this "rural complex" via use of the *Forêts d'Afrique Centrale Evaluées par Télédétection* (FACET) data set which, unlike the GFC dataset, classifies secondary and primary forest separately. Results of this analysis appear in Chapter 4.0.

Despite uncertainties in extent, rate, and nature of forest loss in the DRC, forest in the DRC unquestionably has benefitted over the past decades from "passive protection" provided by conflict, poor governance, and lack of transportation infrastructure (Doetinchem et al. 2016, de Wasseige et al, 2012, 2014). The country's forest ecosystems have not yet undergone the damage observed in other tropical regions, and by comparison are quite well preserved. Although not definitively, this assessment addresses the question of whether DRC is at a turning point beyond which growth in agriculture and logging will lead to significantly higher rates of forest loss, as some have proposed (Doetinchem et al., 2016;, Galford et al., 2015).

3.1.2 SPATIAL ANALYSIS OF CARBON EMISSIONS

To help identify the most critical landscapes, USAID should target GHG emissions from deforestation, forest degradation, and changes in land use. Tetra Tech asked WRI to develop, for the first time, a map showing distribution of forest carbon emissions across the DRC. Although the map produced is innovative, it reveals only part of the complete picture.

Currently, direct measures of changes in forest carbon are not possible via remote sensing. Different data sources must be combined to generate an estimate. To produce a carbon emissions map, WRI correlated the TCL map (Map G-1) to a map of aboveground live biomass density. The biomass density map of DRC came from a map created by co-locating ground-based measurements of forest biomass density (in tons of biomass stored per hectare) with Light Detection and Ranging (LiDAR) waveform metrics to estimate biomass density of more than 40,000 LiDAR footprints throughout the tropics (Zarin et al., 2016). Estimates produced by use

of these two sets of information were then correlated with other variables to create the 30-meter grid map of aboveground woody biomass density for year 2000 (Map G-4)[8] Notably, this map shows aboveground living biomass only—it does not include certain carbon pools, such as belowground biomass, soil carbon, and harvested wood products. It highlights areas of highest aboveground biomass density, principally the remaining primary forest cover, generally found in Equateur and Oriental provinces.[9]

The carbon emissions hotspots map (Map G-5) combines this aboveground biomass density map with the TCL map presented above (Map G-1). Assumptions in generating this combined map were that the entire area represented by a pixel on the tree cover loss map had been completely cleared, and all biomass represented on the second map had been "committed" to the atmosphere. (The calculations used a biomass to carbon conversion factor of 0.5 and a carbon to carbon dioxide conversion factor of 3.67.) The emissions were then aggregated to a 5-kilometer (km) grid, thus creating clusters of high carbon emissions. A second map (Map G-6) shows these clusters in relationship to provinces, roads, CARPE Landscapes, logging concessions, and protected areas.

Due to complexity of forest change, these two hotspot maps reveal only a portion of the story of forest carbon emissions and capture. Most importantly, the map of TCL used in production of the hotspots map is not a map of net forest loss. Much of the area identified as hotspots in the carbon emissions map corresponds to remote regions dominated by swidden agriculture. From a carbon perspective, initial clearing of primary forest in these systems leads to generation of the vast majority of emissions, but the TCL map also includes clearing of young forest on swidden fallows. Swidden cycles of forest clearing, cropping, and regrowth include both carbon emissions and carbon capture. The TCL data on which these maps were based spanned 14 years, and both TCL and TCG occurred in the swidden areas over that period. In addition to regrowth on fallow lands, areas of TCL from overcutting or from fires may also regenerate. The difficulty of accurately detecting slow, incremental changes in spectral response from TCL renders production of an accurate map of carbon emission hotspots impossible at this time. One cannot simply subtract TCG from TCL to determine net loss. As discussed later in this assessment, debate surrounds the role of swidden agriculture in DRC. Because this is the primary cause of forest loss in the DRC, continued development of methods to accurately measure its contribution to emissions will be important.

Analyses failing to take into account causes of changes in tree cover may inaccurately measure impacts of those changes. Nasi et al. (2010) used published and unpublished data to differentiate effects of different causes of forest loss on carbon stocks. They found that when farmers convert primary forest to a swidden system on a 20-year fallow cycle, forest with 380 tons of carbon per ha initially drops and remains under 100 tons. If the same land is converted to an oil palm plantation, it slowly recovers to just over 50 tons before the plantation has to be replaced. By comparison, the most intense form of selective logging drops carbon to 280 tons per ha, but full recovery to the original level of biomass stocks occurs within 20 years.

A second set of biases, tracing to the parameters underlying carbon emissions hotspots maps, involve likely overemphasis on relatively remote areas of swidden agriculture and an underrepresentation of emissions resulting from wood harvesting to feed the charcoal demands of urban centers. For the carbon emissions analysis, forests were defined as areas with trees exceeding five meters in height and with canopy coverage exceeding 30 percent in year 2000. Although some hotspots identified in Map G-6 overlap with areas likely to be in the charcoal supply zones of urban centers (e.g., Kisangani), no clear or obvious correlation is evident between urban centers and emission hotspots. Forests around Kinshasa are under some of the most severe pressure in the country. Studies indicate that at least 4.3 million cubic meters (m^3) of wood is harvested each year within the charcoal supply zone of the city (Schure et al., 2011). Agriculture and artisanal saw timber

[8] Greater detail regarding this process is in the WRI Supplemental Report, Annex G.

[9] Fifteen new provinces were established via enactment of a law on March 2, 2015; however, little has yet occurred to materialize this change, including transfer of financial resources commensurate with additional responsibilities of provinces. All maps used in this assessment are based on boundaries of the old provinces. Throughout this assessment, we also use the old administrative boundaries and names.

harvesting also contribute to carbon emissions around the country's cities. Instead of reflecting these pressures, the hotspots map shows a "statistically insignificant" white ring around Kinshasa.[10]

Because of these technical limitations (inability of available maps to accurately represent net forest loss), the hotspots maps over-represent impacts of swidden agriculture and under-represent other ways in which forest carbon is removed. This absence of accurate representation of forest carbon emissions limits evidence available for development of strategic recommendations for USAID. Nevertheless, these maps may be useful to identify areas of active swidden agriculture, and could serve as initial bases of a future refined mapping product.

3.1.3 BRIEF COMPARISON OF AREAS OF HIGH BIODIVERSITY AND AGRICULTURAL GROWTH

This assessment focuses on the relationship between agriculture and forest loss. In DRC, conversion of forests to agricultural use also threatens biodiversity, decrease of which parallels forest loss because deforestation is the main cause of habitat loss. The landscapes of the CARPE program were created with biodiversity in mind, and define regions for which the US government has invested to conserve. Because of the parallel between conversion of forests to agricultural use and biodiversity, in this section we use available maps in describing threats of agricultural expansion to biodiversity.

To identify areas where deforestation threatens biodiversity, we use the species-ecoregion map developed by the World Bank for a recent transportation study. This map was produced by building an index joining three characteristics of species (diversity, endemicity, and extinction risk) and biome characteristics (World Bank, 2016). Comparing this map to the TCL map accessible on the WRI Global Forest Watch website suggests that greatest overlap of TCL trends with high biodiversity are in eastern Congo, and in the area north of the most northern portion of the Congo River, near the City of Bumba. Map E-1 shows the World Bank map beside the Global Forest Watch (GFW) map of TCL within the same area. Comparison with maps of expansion of smallholder agriculture, presented in greater detail in the next chapter, reveals similar overlaps.

3.2 CAUSES AND CONTEXTS OF FOREST LOSS IN THE DRC

Other sources of information provide little reliable detail to fill gaps in remote sensing concerning direct causes of forest loss, and conditions that determine distribution of and rate of impact on forests. Sources all present similar lists, ranked similarly in order of importance, yet they are not quantified.[11] The common list is a variation on the following:

- Forest clearing for smallholder farming
- Overcutting for wood fuel
- Overcutting for saw timber
- Industrial and artisanal mining
- Commercial agricultural concessions
- Clearing of forests for infrastructure.

Sources all describe clearing of forests for smallholder agriculture as the most important cause of forest loss in DRC. Ickowitz et al. (2015), documents the shortage of available relevant evidence, but ultimately concurs with this consensus. Increases in population density, for one reason or another, constitute the most important factor influencing rates of forest loss associated with smallholder agriculture. Section 4.1.2 below describes in

[10] An earlier version of the hotspots maps based on TCL in primary forests showed the Kinshasa supply zone as a "cold spot," illustrating again the difficulty of identifying areas of forest carbon emissions based on satellite imagery.

[11] See for example, de Wasseige *et al*, 2012, World Bank 2016, and the National REDD+ strategy (Government of DRC [GDRC], [n.d.]). Sources of information on direct causes and their drivers are diverse. The National REDD+ Strategy description of causes of forest loss is based on a synthesis of four separate studies. Doetinchem et al. (2016) provides Congo Basin context on this subject.

greater detail the underlying dynamic and other factors that influence rates of forest clearing for smallholder agriculture.

After smallholder agriculture, over-harvesting of wood and timber are causes of forest loss that both currently significantly surpass mining, plantations, and infrastructure in that regard. Wood fuel harvests clearly outpaces harvesting for saw timber—more than 200 times as much wood is harvested for fuel use than for industrial saw timber. (Section 4.2, Forest Sector, below, presents greater detail on wood harvesting and its impact in the DRC.)

Mining operations, plantations, and roads permanently destroy forest, and convert lands for extended periods of time, yet their direct impacts are largely limited to a specific and relatively small "footprint." Despite the number of people participating in artisanal mining (an estimated 10 million), the principle threat from this type of mining stems from its location rather than its overall surface area (Hund et al 2013).[12] Mining, along with plantations and roads, also influences population dynamics and thus, in turn, forest clearing by smallholders. Many people associated with or employed by mining operations clear land to farm. Plantation agriculture also results in clearing of fields by sharecropping farmers or employees, and in the long run, clearing of land for plantations poses the greater threat of forest loss. However, very little, if any, forest is being cleared for plantations in the DRC currently, and the impact of this largely abandoned sector remains relatively small.

While land cleared for roads in DRC represents a very small fraction of total forest loss, road construction and river clearing for navigation may grow dramatically in the future, and thus significantly increase the rate and extent of forest loss. Available evidence regarding patterns and causes of forest clearing support this claim. Access is one of the most important drivers of a number of direct causes. Smallholders have little control over transport infrastructure and strongly focus their economic activities around available transport routes. Transport infrastructure is one of the most robust predictors of tropical deforestation. Doetinchem et al. (2016) modeled future deforestation in the Congo Basin and found that, of all the different scenarios tested, a scenario modeling improved transportation infrastructure is by far the most damaging to forest cover. Most impacts do not result from construction of infrastructure, but from indirect effects associated with increased connectivity. Following this pattern, in the DRC, forests are cleared less intensely farther from roads, and intense clearing near roads may drop off dramatically at a distance exceeding 2 km. On the other hand, even upgrading roads from very poor to good condition can produce near-complete deforestation alongside those roads (World Bank, 2016). Access, in the form of roads and rivers, supports livelihoods. While remote sensing most easily identifies forest clearing resulting from improved transportation, smallholder production and sale of wood fuels and lumber also depend on access to markets. By changing access to forest and markets, in the near term, improvements to the country's road network may result in the greatest increase in forest loss associated with agriculture. (See Map E-2.)

As changes in infrastructure shape distribution and rate of forest product harvest, growing demand from urban markets increases value of those products. Rapid growth of urban markets for domestic and export sale accelerates forest loss from overcutting for wood fuels and from artisanal logging. Although these supply zones for wood products are unmapped and only roughly quantified, they clearly spread out in increasingly large radiating patterns following the transportation infrastructure.

Consensus has been reached regarding broad categories of immediate causes of forest loss, but reliable numbers regarding volumes and ha do not exist, and clear understanding of dynamic relationships between immediate causes and associated factors awaits additional research. This lack of clarity regarding past change necessarily leads to doubt about any speculation pertaining to future trends. With this in mind, we nevertheless present the following conclusions of a recent World Bank effort to model changes in forest loss in the Congo Basin through 2030:

[12] In the DRC, both industrial permits and artisanal mining sites overlap protected areas significantly, especially in the east, and pose a serious threat to vulnerable ecosystems and biodiversity (Hund et al. 2013; Global Forest Watch, n.d.).

1. Increasing agricultural productivity is not sufficient to limit pressure on forests.
2. Wood extraction for domestic fuel wood or charcoal production will continue to increase for the next few decades, and could massively threaten forests in densely populated areas.
3. Pressure from formal logging is limited, but informal chainsaw logging is expected to progressively degrade forests.
4. Development of much-needed transportation infrastructure could lead to major deforestation by changing economic dynamics within newly accessible areas.
5. Development of mining—a largely untapped source of income and growth in the forest zone—could also lead to significant impacts. (Note: Mining is much more developed in the DRC than in most other Congo Basin countries, but occurs primarily away from forests in the semi-arid southern part of the country).
6. Deforestation rates are likely to increase in the future to sustain development and reduce poverty (Doetinchem et al., 2016).

The following chapters of this assessment provide information on current status, constraints, and impacts of agricultural growth, fuelwood production, and logging in the DRC. While they do not include predictions of future forest loss, they provide context, identify constraints, and offer recommended options for addressing these drivers. Except for the qualification regarding mining noted above, results of research for this assessment generally support the preceding six conclusions of the World Bank modeling effort regarding the DRC.

4.0 AGRICULTURE AND FOREST SECTORS IN THE DRC

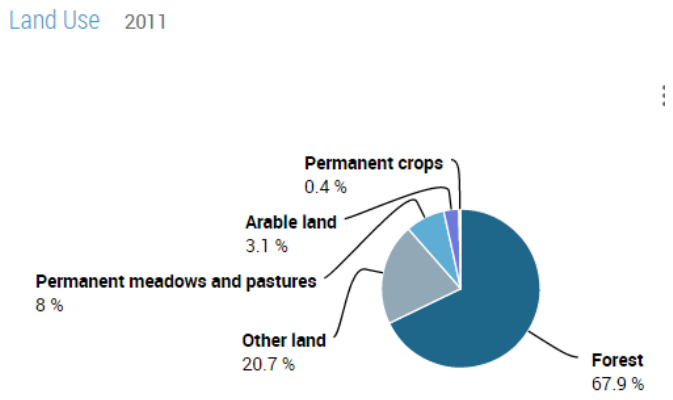
4.1 AGRICULTURE SECTOR

4.1.1 OVERVIEW: NEED AND POTENTIAL FOR AGRICULTURAL GROWTH IN DRC

Increased agricultural production and productivity are critical to food security and broad-based growth of the Congolese economy. Agriculture has great potential for poverty reduction and improving food security. And the need is great. A brutal colonial past followed by governmental dysfunction and conflict have left most of the country's vast agriculturally suitable lands unused, underexploited, or abandoned. Cheap food imports, an oppressive business climate, a collapsed infrastructure, and governmental institutional and policy failings continue to stifle agricultural production and productivity, and create a challenging context for intensifying agriculture and managing its impacts on forests. At the national level, over half of all rural households (about 28 million people) were considered food insecure in 2012. Seven and a half million households were severely affected[13] (Akakpo et al., 2014).

One approach to agricultural growth is to increase exploitation of the country's vast amount of non-forested land suitable for agriculture. Farmers currently farm a very small percentage of the country's landmass compared to other countries in Africa. (Map E-3 shows current land use in the DRC.) Of a total area of 226 million ha, annual crops cover about 6.8 million ha (3 percent)[14], while tree crops encompass a much smaller proportion, 0.8 million ha (0.35 percent). Pasture and working meadows, primarily in the east and northeast, cover the remaining 18 million ha (8 percent), for a total of 30 million ha currently used for agriculture. (See Figure 4.1.) This small proportion dedicated to agriculture, 11.5 percent, compares to the much higher average across Southern Africa, Central Africa, and the continent as a whole (62 percent, 25 percent, and 43 percent,

Figure 4.1. Percentage Agriculture Land Use, 2011



Source: FAOSTAT. 2011. Accessed March 10, 2016.

[13] The province with the highest absolute number of food insecure people was Equateur, while other provinces with food insecurity above the national average include Sud-Kivu, Kasai Oriental, Orientale, and Katanga (Akakpo et al., 2014).

[14] The amount of cultivated land in the DRC varies dramatically from one source to another. Deininger & Byerlee (2011) give a figure of 14.7 million ha. Varying definitions of how to define fallow land in a swidden system may partially account for this discrepancy, but more generally, as Chamberlin, Jayne, and Headey (2014) note: "despite the rapid expansion of … remote sensing information…we lack consistent and reliable data on the location and area intensity of land cultivation."

respectively). Food and Agriculture Organization (FAO) Statistics [FAOSTAT][15] Land Use 2011). In fact, such a small percentage of the country's landmass has been converted to agriculture that, even if we assume agriculture will no longer encroach on forest, 23.8 million ha of land suitable for smallholder agriculture remains unexploited, an amount roughly equivalent to the land currently dedicated to agriculture (Chamberlin, Jayne, and Headey 2014)[16]. Researchers dispute definitions, impacts, and methods of calculation, but the bottom line remains that the DRC contains a great amount of suitable non-forested land that could be converted to intensive agricultural use. However, as history demonstrates, mere presence of these lands does not mean that they will be used. Directing agricultural expansion to these lands remains a challenge.

Constraints to agricultural intensification

Increasing productivity, closing the "yield gap" on lands already dedicated to agriculture, is a second approach to agricultural growth in the DRC. Here, too, potential is great. Technologies exist that could vastly improve performance of the country's various agricultural systems. Yet under-exploitation of agricultural land in DRC has a historical basis in events that continue to affect perceptions and decisions of national decision makers, potential investors, and farmers. This history largely explains why large-scale agriculture plays a meager role in the national economy, and why food crops, largely produced at yields far below their potential, grown in impoverished communities cut off from markets, nevertheless constitute 80 percent of the country's agricultural Gross Domestic Product (GDP). In order of value, the FAO lists the country's most important crops as cassava, plantains, "game meat," maize, and mangosteens. Except perhaps for game meat, these are all produced primarily for household consumption; none is also a primary export product. (The FAO lists the main agricultural exports, by order of value, as tobacco, green coffee, raw sugar, wheat bran, and dry rubber [FAO 2012]).

Large-scale agriculture in the DRC began a long decline in the 1970s, and decreased by 60 percent between 1960 and 2006. In 1967, agricultural exports represented 40 percent of the GDP; they now constitute just 10 percent (GDRC, 2013). At the time of independence, Congo was the second largest exporter of palm oil in the world; today, it *imports* over 50,000 metric tons annually. Once Africa's leader in production of cotton, only small amounts are cultivated in the country today (GDRC, 2010). This decline became a free fall with the "Zairianization" policy of the 1970s, through which the state expropriated commercial agricultural lands from expatriate owners, "nationalized" them, and turned them over to Congolese citizens. The country's two wars since that time have prevented any significant rebuilding of the sector.

With a failing agricultural sector and a booming urban population, the country now depends overwhelmingly on food imports. Approximately one-third of the food consumed in the country is imported (World Bank, 2013). Initiated as a stopgap measure in response to the collapse of domestic production and skyrocketing prices, cheap importation of food has become institutionalized, with vested interests bolstered by urban demand (Africa Leadership Training and Capacity Building Program [AfricaLead] 2014, O'Donnell et al. 2015). One indicator of the out-sized role food imports play in the country's economy is that the value of wheat imported into the DRC in 2011 was four times the value of the country's top 10 commodity exports (FAOSTAT, 2011).

But cheap food imports are not the only factor suppressing investment in agriculture in the DRC. Both large and small scale agriculture face a daunting number of institutional barriers. Fostering national and

[15] Due to the paucity of information regarding land use in the DRC, we rely on FAOSTAT figures for much of this analysis. Despite frequent conflict with other sources, FAOSTATs are often the only estimates available for sets of information, such as different crops or types of land use. They should be treated with caution.

[16] The 23.8 million ha is defined as land not currently cultivated, not forested, not part of National Park systems or other gazetted areas, and which currently has population densities under 25 people per square km.

international investment and closing the country's agricultural yield gaps[17], and increasing returns to farmers on their investments will require cross-cutting reforms including rebuilding the nation's infrastructure and reforming the institutions, policies, and practices that obstruct marketing and value chains. Transformation of property rights and land tenure regimes is also necessary to increase both large- and small-scale agricultural investment and growth. In addition to these broad reforms, within the agriculture sector itself, the government must demonstrate political will and take decisive action to achieve its Comprehensive Africa Agriculture Development Program (CAADP) commitments and implement its national agriculture investment plan (*Plan National d' Investissement Agricole* [PNIA]).

Infrastructure: Although its condition differs greatly by province, government-provided infrastructure in the DRC has deteriorated to virtual non-existence in much of the country. The nation's roadways rank as some of the most incomplete and dilapidated in the world; one cannot even access all the provinces by road from the capital. Most agricultural produce travels by bicycle or is carried by head from the farm to the first market. The government has not kept the country's extensive network of rivers navigable, or the limited rail transport efficient and reliable (World Bank 2016). Only 5.6 percent of rural households and 16.4 percent of all households can access electricity (World Bank Development Indicators). The country's few agro-industrial enterprises have found it necessary to build and maintain the roads they need. They generate their own power. They provide processing facilities for their own produce, and in many cases, also process produce of local small producers. The decrepit status of the country's infrastructure constrains private investment up and down the value chain, and is perhaps the greatest barrier to increased productivity.

Institutional context for business: Commerce, whether in the form of agribusinesses, commercial farmers, or smallholders, faces institutional conditions that compound the constraints posed by the feeble status of its infrastructure. Business must deal with a government rife with corruption, ubiquitous formal and "informal"[18] taxes, dysfunctional state agencies, and a legal system unable to enforce contracts (US Department of State 2015). Nine state agencies tax agricultural products (Murphy et al., 2015). Oligopolies, bribery, and vested interests of politicians delay transit of inputs and raise prices of produce (O'Donnell et al., 2015). The cooperative movement and associations in the country are few, weak, and often dependent on NGO and project support. Financial mechanisms that do exist reinforce inequity. Credit, savings, and other financial services are virtually unavailable to small-scale farmers and actors in the value chain, while large national and expatriate commercial interests can access loans from banks (O'Donnell et al., 2015). The country ranks 131st on ease of access to credit, and 184th on ease of doing business, out of 189 countries assessed (World Bank, 2015).

Land and resource tenure: In accordance with the Constitution and the land law (Loi n° 73-021, as amended by Loi n° 52-83), all land and natural resources in the DRC are the exclusive and inalienable property of the State. Individuals and entities do not have private property in land but gain use rights from the government. To acquire these rights, individuals and entities are required to apply for one of two types of concessions. Congolese nationals may obtain transferable and heritable "permanent" concessions (*concessions perpétuelles*) that are nevertheless susceptible to expropriation by the State. Persons and entities of any nationality may acquire standard concessions (*concessions ordinaires*). Continued possession of a standard concession is subject to terms stipulated at time of allocation, which include a defined duration, commonly less than 25 years, and often also require putting the land to productive use (De Wit 2013; Mpoyi 2013; USAID, 2010).

Despite this national legal framework, in a practical sense, virtually all smallholder agricultural land is subject to customary tenure regimes. The agricultural law of 2011, the first comprehensive agricultural law for the country, confirms use rights of local communities in the lands they traditionally exploit, including croplands,

[17] The FAO classes the rain-fed cultivation of roots and tubers in the non-forested portions of the DRC as 25%-40 percent of yields that could be realized through a high-input system (FAO GAEZ Data Portal).

[18] For example, in 2012 and 2013, the M23 rebel group demanded a tax of $400 from each truck transporting coffee in North Kivu (O'Donnell et al., 2015).

fallow, pasture, and forests. However, the law notably does not confer ownership, proposes no means for titling or registration, and thus far has not changed practice on the ground. Local authorities, often traditional leaders working with government representatives, jointly manage use of rural agricultural land and associated natural resources. As a result, conditions governing use of land vary across the country and continue to follow traditional practice as modified by current political, institutional, and economic factors. The underfinanced formal court system has jurisdiction over tenure disputes, but lacks skills and capacity, and is susceptible to interference by political and military leaders. This poorly adjudicated regime of unclear, unrecorded, and ill-administered rights facilitates and enables perpetual conflict. Particularly in the eastern portion of the country, this tension has often turned violent, with damage to agricultural productivity only one of many negative impacts (Mpoyi, 2013; Défis sud 2012; USAID, 2010).

Government action to improve the tenure system has been limited, and not always without dispute. To reverse concentration of power that has occurred in DRC for decades, and in consideration of the country's size, the 2006 Constitution defined DRC as a unitary but decentralized state. Of legislation enacted following the 2006 Constitution, Article 16 of the 2011 Agriculture Law, regarding acquisition of concessions, has proven the most controversial. This article requires that applicants for agricultural concessions either be of Congolese nationality, or, if an entity, be majority owned by Congolese. While possibly conceived as a firewall against international land grab speculation, this clause also raises the specter of a devastating collapse of international investment similar to that of the 1970s. In either case, it is currently interpreted as one more factor in the overall business climate that conflicts with the National Agricultural Investment Plan (*Plan National d' Investissement Agricole* [PNIA]) and bars foreign investment. Despite speculation that Article 16, (apparently introduced by the President's Office without public consultation),would be modified, it remains in place (Défis sud, 2012; AfricaLead, 2014, Emery Mukendi Wafwana & Associates [EMW&A, 2013).

The country's land law, essentially 40 years old, must be updated, as was the Agricultural Law, to harmonize with current conditions and national policy and practice. Modification is necessary to better support national land planning efforts, and facilitate natural resource management. Authority of the various ministries to grant concessions and otherwise administer rights in land and land-based resources has to be clarified. Enforcement of these concessions and rights also must proceed in a transparent manner. Land legislation also needs to be updated to concur with the country's international commitments, as should the regulatory language of some ministries that recognize that the rights of indigenous populations are currently not formalized (Mpoyi, 2013).

Beginning with the 2006 Constitution, the country has gradually moved toward formalization of collective and individual land ownership at the local community level. The 2006 Constitution created a framework for decentralization of national authority and responsibility, and envisaged transfer of competencies in agriculture and other sectors to the provinces. This process included increasing the number of provinces from 11 to 26. Continuing this decentralization process specified in the constitution, the 2011 Agriculture Law created agricultural advisory boards at national, provincial, and local levels. Once established, boards at the provincial level are to help mitigate community-level disputes over lands, although few concrete actions have been taken thus far.

As another step in the decentralization process, the government has recently formalized a process for communities to acquire forest concessions. Following the 2002 Forestry Code, and recent enabling regulations, communities may now apply for rights to manage and exploit forest[19]. This new policy does not weaken the state's ownership of community forest land; nor does it explicitly address agricultural land. It nevertheless constitutes a step toward local community management of agricultural land, especially because in rural DRC, new agricultural lands are most commonly created by clearing forest.

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19 Decret n°14/018 of 2014, and the February 2016 Arrêté n°025 by the Ministry of the Environment, Conservation and Sustainable Development. Annex F presents the new Arrêté n°025. The forest sector section, following, describes this new decree, and its strengths and weaknesses, in detail.

Constraints to agricultural intensification: factors within the agriculture sector.

National Agriculture Budget and Policy. The GDRC signed its CAADP country compact within the African Union Commission in 2010. The 2013-2020 PNIA developed within the CAADP framework constitutes the country's roadmap for domestic and foreign investment in the agriculture sector and rural development. Its overall objective is to stimulate sustained rate of annual growth of 6 percent in the agriculture sector. The five components of the plan address agribusiness, food security, agricultural research, agricultural governance, and climate change. To achieve progress in these areas, the GDRC has committed to increasing expenditure in the agriculture sector to 10 percent of the national budget by 2020 (GDRC, 2013).

The most visible component of implementation of the PNIA has been the *Bukanga-Longo AgroPark*, part of a $6 billion plan to build 20 agro-industrial business parks discussed later in this assessment. Other visible concrete steps within these components have been few, and if public spending is an indicator of overall progress, the country is unlikely to meet its target of agricultural growth. In late 2012, agriculture sector spending was at 2 percent of the national budget, the lowest among its Central African neighbors. Officials maintain that in 2015 they surpassed 3.5 percent. (For comparison, the Republic of Congo spends close to 14 percent, Zambia 10 percent, and Ethiopia over 20 percent.) In 2013, of a total of $5,730m budgeted for the PNIA, only $857 million had been committed, 93 percent of which originated from donors.

Extension: Government extension services in the DRC face serious funding constraints. According to a 2013 Consortium for Improving Agriculture-Based Livelihoods in Central Africa **(CIALCA[20]) REPORT,** the government has not funded agricultural extension service to provide technical assistance in the field since 1997 (Macharia et al., 2013). A recent in-depth review (Ragasa et al., 2013) also identified weaknesses in human resource management and absence of coordination among extension system, research and education institutions, communities, and farmers. Although the Ministry of Agriculture employs a very large staff of 11,000 field agents, they are under-resourced and focus efforts on monitoring rather than providing technical advice to producers.

Research and development (R&D): The country has substantially increased investment in agricultural R&D in recent years. It has also brought on many new junior researchers in the national institutions 'Institut national pour l'Etude et la Recherche Agronomique (INERA) and Centre de recherches agro-alimentaires (Agri-Food Research Center) (CRAA). Despite these gains, investment in R&D remains well below the average in Africa relative to the value of national agricultural production, and the country supports only three researchers per 100,000 farmers. Women are critically under represented among the country's research staff (Agricultural Science and Technology Indicators [ASTI]/International Food Policy Research Institute [IFPRI], 2013).

Figure 4.2. Key Agriculture Research Indicators

CROSS-COUNTRY COMPARISONS OF KEY INDICATORS

	Total number of researchers, 2011 (FTEs)	Growth in number of researchers, 2008–2011	Share of PhD researchers, 2011 (FTEs)
DR Congo	**423.9**	**25%[a]**	**13%**
Rwanda	180.4	44%	12%
Burundi	132.3	32%	18%
Kenya	1,150.9	13%	32%

[a.] For DR Congo, this growth is based on data for the 2009–2011 period.

Source: ASTI/IFPRI, 2013

Conclusion regarding the overall context for agricultural intensification.

The country's history of agricultural production based on plantations, now largely abandoned, and activities of under-resourced smallholders are bases and facilitators of the current unsustainable exploitation of the country's agricultural soils. The national agriculture sector is dominated by a system of extensive agricultural production that addresses declining soil fertility and crop yields by clearing new lands. Reversing this trend and setting the country on the path of sustainable agricultural growth requires more than increasing government (and donor) spending in agriculture. The country's critical gaps in human capacity, policy,

infrastructure, political stability and governance, and policies also contribute to agricultural stagnation in the Congo. Implementation of the government's most comprehensive plan to address these barriers, the PNIA, progresses only haltingly, while widespread agricultural intensification and sustainable growth without progress in the larger enabling context is difficult to imagine (AfricaLead, 2014).

4.1.2 SAVANNA: POTENTIAL FOR INTENSIVE AGRICULTURE ON NON-FORESTED LANDS

Is DRC's savanna a vast reserve available for agricultural expansion? One approach the ProLand SI Working Paper identifies as a means to mitigate potential for agricultural conversion of forest is to target investments away from forests. In the DRC, the most important opportunity of this kind is investment in the country's savannas and grasslands. Recent global and regional studies that explore how to spare the world's forest while meeting future food security needs identify DRC's abundant, low-population, non-forested land as possible areas for future cultivation. While few of these studies explicitly associate these lands with savanna, unlike forest land, savanna is not explicitly excluded as an option in any of them. Given the large amounts of available land proposed, DRC's savanna must be assumed to fall into the "available for cultivation" category. (For examples of these calculations, see Deininger and Byerlee [2011] and Chamberlin, Jayne, and Headey [2014]). One study has concluded that only five countries have more "prime" or "good" agricultural land than DRC that is not also farmed, forested, protected, or built up (Alexandratos and Bruinsma, 2012). A recent World Bank study of economic growth and deforestation in the Congo Basin estimates presence of 40 million ha of such "available" land in the Congo Basin, and notes that this corresponds to more than 1.6 times the area currently under cultivation. The study recommends that decision makers prioritize this land for agriculture, listing it as a "no-regrets" option (Doetinchem, 2016).

Lambin and Meyfroidt (2011), while still classifying DRC's savanna as potentially available for agriculture, note that introducing agriculture to regions of the world such as these generally exacts social and environmental costs, as savanna is often used by agro-pastoralists and is biologically diverse. Searchinger et al. (2015) also attempt to dampen enthusiasm for agricultural conversion of these lands, and have put the question to test by roughly quantifying losses in carbon and biodiversity that conversion of Africa's high rainfall savannas would entail, relative to global averages. They conclude that, although savannas are not forested, their low agricultural productivity severely reduces any advantage as compared to the global mean "carbon cost" of conversion. Only on the most productive savanna is the ratio of crop produced/carbon lost significantly higher than the global average. As to biodiversity, they compare numbers of species (weighted by taxon to compensate for the greater diversity among birds, relative to mammals and reptiles), and find a richness of savanna comparable to that of tropical forest. They conclude that to properly assess the multiple costs of agricultural conversion of these lands, assessments are required at a much smaller scale. These assessments should include not only carbon and biodiversity costs, but also should integrate expected yield, social implications, and loss of current agricultural activities. In the same vein, Hourticq et al. (2013), while recommending prioritizing agricultural expansion in non-forested areas of the Congo Basin, recommends that tradeoffs be identified and negotiated through a "comprehensive, participatory land use planning" exercise (Hourticq et al. (2013).

No such land use planning exercise has been conducted in the DRC. But the limited information suggests that introduction of intensive agriculture on the savanna would exert significantly less impact on carbon emissions than continued expansion of agriculture into forests. Savanna in the DRC has been classified into five different types, each with a different pattern of vegetation ranging from grasslands to relatively dense forest cover of up to 60 percent trees (Vancutsem et al., 2006, 2009). (See Map E-4). While agriculture and use of fire have created some of this savanna (in particular the grasslands), none of it is heavily farmed currently. According to the National REDD+ Strategy, swidden agriculture is not practiced on the savannas. A few farmers practice mechanized farming around the capital, and in Katanga province farmers intensively cultivate 30,000 ha using fertilizers, pesticides and herbicides, and irrigation. Agriculture is nevertheless likely feasible on this land; the FAO has produced suitability maps for staples that indicate a high level of agro-

ecological suitability for cassava, groundnut, sweet potato, sorghum, and soybean in the savanna of Katanga province, and Bas-Congo. (See Maps E-5 and E-6.) Cultivation of these or other crops within the country's savannas would exert environmental impacts. A rough examination of the species-ecoregion index-based map introduced earlier, indicates that biodiversity of the savanna in the west and southeast of the country is relatively high, while in the central southern portion, biodiversity is intermediate (Map E-1).[20]

4.1.3 SWIDDEN: POTENTIAL FOR INTENSIFICATION

Crosscutting and sectoral constraints to agricultural intensification described in the overview above affect potential for agricultural growth and intensification differently for different types of agriculture. One type of agriculture, swidden cultivation of staple crops, dominates small-scale systems. In swidden systems, farmers clear land, removing any valued products, burn the dried vegetation, crop it for a few years, let it fallow, and then cut the regrowth and burn the dried vegetation *in situ to restart the cycle*.[21]

Improving land efficiency of this practice has been identified as one means of "land sparing" that could greatly reduce the impact of agriculture on the country's forests. The ProLand SI Working Paper identifies substitution of agricultural inputs for fallowing as a means of intensifying agriculture and, under certain conditions, reducing pressure on forests. Proper substitution of inputs can maintain yields and, correctly done, produce markedly higher yields—in some cases doubling or tripling a farmer's annual harvest over traditional swidden systems (ProLand SI Working Paper). However, changing to input-dependent agriculture requires presence of certain conditions, including accessible markets, farm gate prices high enough to justify cost of inputs, and available additional labor. Changes in tenure of forested and agricultural land may also affect the transition. Moreover, research has indicated that in communities bordering forests, any forest management practices that effectively constrain forest clearing can stimulate farmer transition away from fallow systems (ProLand SI Working Paper; Van Vliet et al., 2012).

Fallowing and Soil Fertility

Fallowing can be a sustainable and effective means of renewing soil fertility. Regrowth of sufficient vegetation on fallow restores soil organic matter and nutrients. It improves soil properties and suppresses weeds. To generate a fixed amount of produce, if fallows regenerate sufficiently, farmers can sustainably and continuously cultivate the same complex of fields and fallow (Thrupp, Hecht, and Browder, 1997). On the other hand, to generate an increased amount of produce, farmers must clear more land for the system to remain sustainable. When additional land is not available, farmers may increase production by shortening fallow periods, but as they shorten fallows, soil organic matter declines, soil nutrients are depleted, vegetative regrowth deteriorates, and yields drop over time (Palm et al., 2013).

At the same time, transition to non-fallow continuous farming also poses a host of technical challenges. These barriers vary geographically, but the most commonly cited short-term challenge is dramatic increase in weed population demanding significant increases in labor. The most common long-term challenge is maintaining soil fertility. Partial intensification that undermines productivity of soil is common in Africa. As farmers shorten fallows, they sometimes introduce higher yield varieties. Sometimes they also introduce mineral fertilizer. They more rarely adopt the additional practices necessary to maintain levels of organic matter in the soil. With insufficient soil organic matter, the crops respond less well to application of fertilizer. This, along with practices that increase soil acidity, and inattention to micro-nutrients has resulted in a steady drop of yields and increase in pressure to clear land across the continent (ProLand SI Working Paper; Jayne, Chamberlin, and Headey 2014).

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20 Although, by definition, less biomass covers savanna than forests, and stocks less carbon, as explained previously, due to limitations in available data, the carbon emissions maps produced for this study present a biased depiction of relative carbon emissions over time.

21 Thrupp, Hecht, and Browder (1997) define "shifting" agriculture (for which we are using the term "swidden") as any temporal and spatially cyclical agricultural system that involves clearing of land followed by phases of cultivation and fallow periods.

The extent to which shortened fallows and other forms of non-sustainable intensification affect the soils of DRC's farms is unknown. Fallow periods vary greatly across the country from over a decade to a few years. Within this variation, much is unknown and much is contested regarding relationships among swidden agriculture, national demographics, and increased deforestation. Evidence to inform the debate is limited. It is nevertheless clear that, because fallow systems produce largely for domestic consumption, and not for commercialization, demographic factors generally determine demand. As a result, population growth tends to be the main reason for farmers to attempt to increase production by clearing more land or shortening fallow periods. While it is known that the country's annual rate of population growth is relatively high (2.45 percent, according to the CIA WorldFactbook, making it 26th in the world), a national census has not been conducted since 1983, so accurate estimates of population size and distribution are unavailable. Rates of migration to urban centers and away from conflict are also high, yet they have not been accurately measured either. Understanding migration patterns is important because it affects rates, and possibly the process, of swidden expansion. In areas of in-migration in eastern DRC, for example, fallows likely have been shortened. However, the relationship between population and deforestation cannot be quantified, as fallow durations are unknown and farmer criteria for shortening fallow and clearing primary forest have not been adequately studied (Tollens, 2010; Ickowitz, 2011; Ickowitz et al., 2015).[22] In fact, in recent years researchers have emphasized this absence of understanding in an effort to disprove, or at least undermine, the persistent characterization of swidden agriculture as backwards and particularly destructive to forests (Tollens, 2010; Pollini, 2014; Ickowitz et al., 2015).

Engines of swidden agriculture in DRC

Although the dynamics of swidden agriculture in DRC remain disputed, a recent effort to map its impact on forest cover has successfully documented changes in distribution of fields, fallow, and secondary forests associated with swidden systems between 2000 and 2010. Over this period, these lands, which they call "the rural complex," grew by 10.2 percent (46,182 ha), and increased from 11.9 percent to 13.1 percent of the total land area. The study also documents high variation in rates of change in the rural complex across the country. Joining this spatial analysis with available field-based literature, the study identifies six different forms of rural complex, and the associated contexts in which swidden agriculture may contribute to deforestation (Molinario, Hansen, and Potapov, 2015). The results below, drawn from the study, remain indicative. Molinario, Hansen, and Potapov did not measure the size or exact rate of expansion associated with each of these forms of rural complex. Map E-1 displays the Molinario map that summarizes changes in the rural complex from 2000 to 2010. An interactive version of the study results is accessible at http://congo.iluci.org/shiftingcultivation.

The Molinario Study

Molinario, Hansen, and Potapov (2015) used Geographic Information System (GIS) technology to apply spatial rules to *Forêts d'Afrique Central Evaluée par Télédétection* maps of forest cover for 2000, 2005, and 2010, to identify forest clearing associated with changes in the "rural complex," which they defined as "a characteristic land cover mosaic of roads, villages, active and fallow fields and secondary forest."

Frontal rural complex expansion: This expansion of a band of cleared land into forest along the margins of the rural complex results from rapid influx of people in the absence of agricultural intensification. Molinario, Hansen, and Potapov identify North and South Kivu as areas where disruption of conflict and influx of refugees are causing the country's most rapid growth in the rural complex as this shifts west into primary forest.

Rural complex expansion radiating from villages and towns: Less commonly, swidden agriculture has expanded out from urban centers into forest, presumably in response to population growth and in-migration. The study identifies the area south of Kisangani as an example.

[22] Karsenty (n.d.) asserts that increased weed burden, not loss of soil fertility, causes farmers to abandon land farmed under longer fallow periods. If this is the case, it raises the additional question of conditions under which loss of soil fertility triggers clearing.

Rural complex expansion connecting existing linear features: Swidden agriculture also expands out from new roads, and from rivers and roads improved for transportation. The road between Bwafalinga and Opienge is one of many examples.

Lower impact swidden cultivation: Swidden agriculture has been expanding at a slower rate, with lower environmental impact, in some remote established communities within primary forest, or at its frontier. The west of Lubutu is an example of this type.

Expansion of isolated forest perforations: When people move into primary forest to engage in extractive operations, such as mining or logging, they also clear forest to farm. When roads are built to these operations, farmers will clear fields alongside them. Molinario, Hansen, and Potapov report a near doubling of this "spatial intrusion" into primary forest during the period studied. Although this occupies a much smaller surface area than other types of rural complex studied, it may be more disruptive to intact forest.

Minimal change: Molinario, Hansen, and Potapov also identify areas in which the rural complex has not appreciably grown, and does not threaten forest. Presumably, in these remote areas undergoing out-migration and poor market access, greater demand has not driven an increase in production. Here, fallows are long enough for soils to regenerate fully. Molinario, Hansen, and Potapov present the area between Kisangani and Opienge as an example. In other cases, forest cover has increased as communities have discontinued farming, such as the area north of the road connecting Lubutu and Kisangani.

Mirroring a colonial perspective, the GDRC considers the swidden system "traditional," as opposed to modern, and a key constraint to growth of the country's agricultural sector. As the AfricaLead assessment of government agricultural policy notes, perceptions and policy that characterize smallholder agriculture as a national blemish create barriers to collaborate with, build on, support, and strengthen the dominant form of agriculture in the nation (AfricaLead, 2014). Swidden agriculture is commonly presented as the immediate cause of deforestation in the DRC, with population growth the "ultimate" driver behind the scenes This analytical distinction between proximate and ultimate drivers of deforestation serves to clarify discussions of deforestation, yet it should not lead to the conclusion that the part of the equation to focus on, the "thing to fix," is necessarily the agricultural system. Although their actions are the direct cause, expecting reform among the most resource-poor segment of society may not be effective (Pollini, 2014).

The Molinario, Hansen, and Potapov study confirms that a more rapid expansion of swidden agriculture correlates geographically with transportation routes, access to markets, and areas of higher population density. These areas most likely present favorable conditions for intensifying swidden agriculture. However and notably, that transition to continuous cultivation, even if successful in maintaining soil quality, will not necessarily "save" forest and other natural lands. As pointed out in the approach section of this paper, global research indicates that if farmers succeed in converting to sustainable, land-intensive agricultural systems, they will concurrently increase incentives to clear land. Widespread increases in yield and returns increase farmer motivation to invest in agriculture, and if not constrained from doing so, to increase land holdings. Agricultural intensification may also draw migrants, increasing pressure to clear new lands. Further, once the transition has occurred, lands converted to non-fallow intensive systems become permanently deforested, store less carbon, and support reduced levels of biodiversity than fallow systems (ProLand SI Working Paper; Van Vliet et al., 2012). In fact, absence of commercial agriculture and dependence on swidden agriculture is one reason why deforestation rates in the DRC are much lower than other countries further along in the process of intensifying their agricultural systems. In contrast to swidden, market demand drives expansion of capital intensive agriculture, not population pressure. Driven by growing market demand, widespread capital-intensive smallholder agriculture will likely exert greater, not less, pressure on the country's forests.

4.1.4 EASTERN DRC: UNIQUE POTENTIAL FOR AGRICULTURAL INTENSIFICATION

Despite potential for increased pressure on forested lands, raising yields from land should be one element of an approach to agricultural growth that mitigates impacts on forests in the DRC. As noted above, cost-

effective access to input and produce markets is necessary to increase land efficiency and "spare" land. At a minimum, farmers must be able to sell their produce at a high enough price to purchase the inputs necessary for intensification. In the DRC, the densely populated eastern provinces may be the only region where these conditions are in place. North and South Kivu, in particular, have potential for intensive agriculture. The high elevation of North and South Kivu sustains a temperate climate with the highest average rainfall and lowest temperatures in the DRC. Soil organic matter breaks down more slowly in the cooler climate. The area's climate and fertile volcanic soils thus create a highly suitable agro-ecological foundation for agriculture. In addition to a wide variety of crops, local producers dedicate land to livestock. Roughly a quarter of the country's cattle and small ruminants are raised in Katanga province and South Kivu. In North Kivu, much of the pasture is occupied by large cattle ranches.

The region also faces many of the constraints to agricultural growth confronted elsewhere in the country. More so than elsewhere, the region's agricultural potential has been undermined by a long history of conflict. Post-independence turmoil was followed by wars between 1996 and 2003, during which conflict among multiple rebel groups and the government forces displaced large portions of the population and disrupted production. This conflict still simmers, and the effects are still felt. In 2014, most of the country's 2.7 million internally displaced people were in eastern DRC, and over 400,000 Congolese refugees had fled to Burundi, Rwanda, Tanzania, and Uganda. During the 2011 to 2012 season, less than 60 percent of households in the Kivus farmed. Few of those who did farm that year used improved seed varieties—less than 10 percent in South Kivu and less than 20 percent in North Kivu. They have infrequent access to good quality inputs of all sorts, and no large commercial firms and few government agencies provide fertilizer. Access to land is also a constraint, for new migrants as well as returning displaced people. Given the high population density, and its unequal distribution, access to land remains a source of tension. Transportation costs render most produce uncompetitive elsewhere in the DRC. Despite their great agricultural potential, the two provinces of North and South Kivu now rely heavily on food imports and emergency food aid, and have the highest rates of food insecurity in the country (Murphy et al., 2015; O'Donnell et al., 2015).

As insecurity abates and agricultural production in the region grows, sustainable increases in productivity of land in eastern DRC will require adoption of a suite of practices that improve and maintain soil fertility. These include organic inputs and mineral fertilizer, improved plant varieties, and good planting patterns (intercropping and crop rotation). Partial adoption of these practices results in yields significantly lower than those expected from adoption of them all in combination. While farmers may recognize the synergistic effect of these changes, they are often constrained from adopting the more land and capital-intensive ones. This leads farmers to plant improved varieties in the absence of fertilizer or new planting patterns, both of which are necessary to maintain soil fertility in the long term (Lambrecht et al., 2014). Incomplete soil fertility management will lead to reduced soil productivity and, in the long term, to efforts by farmers to seek and clear new land, as elsewhere in Africa. Map E-7 identifies significant areas of primary forest loss in Northern Kivu over the 2000-2013 period. This change in forest cover appears alongside roads, and to the north, expands as a broad front. Influx of new migrants, road building, greater investment in agriculture, and the extensive nature of the agriculture practiced likely all contribute to forest loss. (Greater understanding of impacts of these different potential causes awaits results of on-the-ground research.)

Conclusions regarding agricultural intensification

Despite great need for increases in agricultural productivity and output, significant challenges prevent the DRC from achieving its potential for agricultural growth. Policy, economic, infrastructure, and governance constraints reinforce more specific limitations within the agricultural sector to create real barriers to fostering agriculture on unexploited non-forested lands, and increasing yields on lands presently farmed. Sustained intensification of the swidden systems in which the vast majority of farmers are engaged requires, at a minimum, improved crop prices and access to inputs. Presently, these conditions might be met only near urban centers, and in the densely populated agricultural zones of eastern DRC. The conditions and process for allocating concessions constrains investment in perennial crops, and tenure further complicates renewing

use of the extensive lands of underproductive and abandoned plantations. In cultivation of either staple or perennial crops, any intensification that appears successful in the short run risks further reduction in soil fertility, and thus promotion of extensification in the long run. This partial success may also increase incentives to engage in or invest in agriculture, and increase pressure on the country's forests.

4.1.5 POTENTIAL FOR INTENSIFICATION OF CULTIVATION OF PERENNIAL CROPS

The ProLand SI Working Paper notes that because certain perennial tree crops are better adapted to tropical environments than exotic temperate crops, in countries like the DRC, they have a comparative advantage, and may generate more revenue per ha than alternatives such as maize or wheat. Tree crops can be cultivated at the household level, or at an industrial scale, and efficient commercial mono-cropping of some (palm oil and rubber) may generate larger yields per ha than those from smallholder production. These two crops are most efficiently processed at the industrial scale, while initial processing of coffee and cocoa can occur in villages. As a group, tree crops tend to maintain soil fertility longer than annuals because they provide continuous cover, do not require frequent turning of soil, and draw up nutrients from the subsoil. Regarding their impact on forests, in cultivation with other crops or within forests, tree crops may support a broad range of ecosystem products and services. They also generally employ more labor per ha than many staple crops. Thus, investments in tree crops may be part of a strategy to minimize effects on forests; they may be produced in land-efficient systems, generally require additional labor, and in some cases retain ecosystem products and services (ProLand SI Working Paper). Despite these factors that mitigate their impact on forests, expansion of perennial tree crop cultivation has caused extensive deforestation over the past several decades. The FAO reports that land dedicated to rubber and cocoa worldwide doubled from 5 to 10 million ha between 1985 and 2015, while land dedicated to palm oil almost tripled, from 5 to 19 million ha. In countries where this expansion has occurred, it has largely been at the expense of forest (Wilcove and Koh, 2010; Meyfroidt, Rudel, and Lambin, 2010).

Little investment in DRC's holdings of perennials has occurred in recent decades, and production now represents but a small fraction of that the plantation system once contributed to world markets (GDRC n.d.). The country produces palm oil and *Hevea* (rubber), coffee, and cocoa as export commodities. (Yet little palm oil is exported, and production does not meet national demand.) The requirement that most investment in concessions must come from DRC nationals, cited earlier, is regarded as the most severe constraint to investment in tree crop concessions. Additional constraints include delays in processing applications, required occupation of land within six months of allocation, and poor sharing of information about granting of concessions between Ministries and provincial governments (Deininger and Byerlee, 2011). Revitalization of existing plantations is also limited by land tenure confusion and conflict. While questions have been raised concerning legitimacy of claims of concession holders, previous employees and displaced persons have taken up cultivation of trees on many former plantations. In some cases, former workers who continue to cultivate parcels on plantations have disputed claims of new concession holders. Vidal (2015) and De Wit (2013) cite the Luhonga case in North Kivu as an example. These barriers to reviving the lost industry of large-scale commercial plantations, as well as risks this path poses to forests, local communities, and indigenous populations, hinders the sub-sector so much that the REDD+ Strategy proposes a national discussion regarding how the country should advance perennial tree crop production.

Palm oil

These constraints and opportunities for intensification affect different crops differently. Until the 1980s, most of the country's palm oil plantations were owned by the conglomerate *Société Générale de Belgique*. Today, the two largest companies are the *Groupe Blattner Elwyn* (GBE) and the Canadian company Feronia. GBE, which also produces rubber and cocoa, is the country's largest palm oil producer occupying seven distinct sites, five of which produce palm oil. On these sites, in Equateur and Bas-Congo Provinces, GBE manages its own trees but also purchases from sharecroppers. The company holds a significant amount of non-productive land on its plantations. Of a total of 24,000 ha reported on the GBE company website, only 10,000 ha is under direct production by the company, while 5,000 ha is sharecropped. The remaining 9,000 ha is not

producing (GBE website, http://www.gbedrc.com/index.php?lang=en). Feronia has plantations in Tshopo, Mongala, and Equateur provinces. According to its website, Feronia produces about 13,000 metric tons (MT) of palm oil a year, employs 3,800 people directly, and has replanted about 17,000 ha since 2010 (Feronia website, http://www.feronia.com). Since purchasing the plantations from Unilever in 2009, Feronia been replanting trees, not expanding to new forest. Feronia has now replanted all but 5,000 ha of the concession land previously purchased from Unilever (interview, Batanga). Each site managed by these two companies has its own processing plant, as well as other services, such as clinics. Together, GBE and Feronia produce 258,000 MT a year (interview, Batanga). FAO reports a national production of 300,000 MT in 2013, sharply up from a production level consistently between 150 and 200 MT for 1976 to 2010 (FAOSTAT, 2011).

The government sees reviving this sector as a great opportunity. The PNIA notes growing international competitiveness of perennial crops, and proposes actions in line with the PNIA's overall strategy of "modernizing" agriculture. This consists of promoting large-scale commercial schemes on rehabilitated and new plantations (*Ministère de L'agriculture et du Développement Rural*, 2013). In line with these expectations, the GBE website states that GBE is preparing for competition from foreign investment. A decrease in production of palm oil in Asia as land becomes less available is projected to generate strong increase in export demand. Palm oil provides almost 90 percent of the fat consumed in the DRC, so the domestic market is likely to remain strong (GDRC, n.d.).

Producing for these markets will require resolving business investment and land tenure constraints noted elsewhere in this document. Further, for palm oil companies, the land tenure issues hindering attempts to revive abandoned plantations not only limit expansion of production, but create reputational challenges for companies. Following influx of squatters on the plantations in the early 90s, the land tenure conflicts constrain use of virtually all abandoned plantations (interview, Huart). No abandoned plantations have been replanted within the past decade. They have been tied up in ownership and tenure claims (interview, Batangam). These conflicts with local communities appear to be a major reason GBE and Feronia have been unable to meet Roundtable on Sustainable Palm Oil production (RSPO) Principles and Criteria on Sustainable Palm Oil Production. Feronia reports that it is implementing International Finance Corporation (IFC)/World Bank standards for environmental and social sustainability, and GBE has entered into open negotiations with communities on one of its sites over lands it has held since the early 1900s in an attempt to calm local complaints (Feintrenie, Roda, and Rival 2016). Neither, however, has been able to obtain RSPO certification due to these ongoing conflicts with local communities.

Investment from foreign entities has also not met expectations. No large land agreements have been confirmed. According to a rumor in 2015, the Chinese company ZTE had agreed to buy 100,000 ha for a palm oil plantation (IIED 2015), but rumors such as this also circulated in 2010 and date from 2007 (Tollens 2010), suggesting that here, as in other countries in Africa, the speed at which the global "land grab" will occur, if at all, has been exaggerated. In DRC, even the government's plan to revive existing plantations requires resolution of serious tenure issues before it can move forward (interview, Ulimwengu).

Rubber

The history of rubber production in the DRC resembles that of palm oil, and current constraints are the same, although production is less than one twentieth the volume of palm oil production. Rubber plantations were first introduced in DRC during the second decade of the 1900s, and were critical to success of allied forces during World War II. Production today, principally from Equateur province, is less than 10,000 MT (Tollens, 2010; GDRC, 2013). Although world demand for natural rubber is increasing, production in the DRC has been constant since 1990 (FAOSTAT, 2011). Today, as elsewhere in much of Africa, after the collapse of the plantation system in DRC, smallholders produce and conduct initial processing of rubber.

Cocoa

Wherever it is cultivated, cocoa offers potential for broad-based economic growth. Most commonly cultivated at the household level by millions of small (1-2 ha) and medium-sized (4-5 ha), family-run farms, demand for cocoa has outpaced worldwide production in recent decades (International Institute of Tropical Agriculture [IITA], n.d.). Cocoa cultivation is also a potential means of limiting impact of agriculture on forests. The ProLand SI Working Paper identifies cocoa cultivation as a possible "land sharing" option because cocoa is naturally an understory plant and its cultivation under shade trees increases long-term performance, principally by reducing pest burden and improving soil health (Tscharntke et. al., 2011). Cocoa thus produced under shade retains many ecosystem functions in a manner similar to natural forests, including diversity of some species, water regulation, and partial carbon storage (Minang et al., 2014). Some cocoa agroforestry systems in South Cameroon have a canopy cover of over 80 percent (Bisseleua, Missoup, and Vidal, 2009). Cultivated alongside intact forests, with sufficient local and external support, shaded cacao cultivation can also reinforce buffer zones, reducing forest edge effects and increasing connectivity among forested habitats.

Although it is a "land sharing" option, spread of cocoa farming has significantly affected the continent's natural lands and, according to the IITA, has "led to the near disappearance of the West African rainforest" (IITA, n.d.). Forest loss has been more extensive and more rapid because farmers have not adopted land-intensive practices when growing cocoa, but opted for clearing new forest when soil fertility has declined (De Beule, Jassogne, and van Asten, 2014). Further, because the role of shade trees is poorly understood, farmers often convert shaded to unshaded systems to increase short-term yield, thus reducing the ecosystem products and services retained (Tscharntke et. al., 2011).

The status of cocoa production in the DRC

Whether cultivation of cocoa in the DRC will have the same long-term impact on the forests as it has had in West Africa will be a function of government, donor, and private-sector success in managing the manner and spread of the crop's production, processing, and sale. The starting point for the DRC differs significantly from the West African context. The Belgian colonial power, using brutal means, introduced plantation-based cocoa production to the country in the late nineteenth century; only 10 percent of total production came from smallholder farms (GDRC, 2010). Nor has production ever come close to that of West Africa. At independence, plantations in the core production areas of Bas Congo and Equatorial Province produced 5,200 MT annually. After peaking at 6,300 MT in the 1980s, production dropped to 2,000 MT in 2006 (GDRC, 2010). FAOSTAT reports slightly higher figures, and a more recent decline. By comparison, the International Cocoa Organization reports that the Cote d'Ivoire produced 1,746,000 MT in 2014, over 250 times DRC peak production (International Cocoa Organization, n.d.).

Today in DRC, none of the old cocoa plantations functions. Just over a thousand independent farmers currently sharecrop with what once was the largest company in Bas Congo, the *Société de Cultures et d'Industries Agricoles au Mayumbe* (SCAM). Despite buying farmer produce, the company itself is taking out cocoa trees to plant rubber trees (*Hevea Braziliensis*) (De Beule et al., 2014). The scattered smallholders who do continue to produce struggle with exhausted soils and dated tree stock. Their yields are very low, at 200 kilograms (kg)/ha versus 450 kg in Cote d'Ivoire and over 750 kg in Vietnam (De Beule, Jassogne, and van Asten, 2014).[23]

Generally, smallholder activities are concentrated in the old core production regions of Bas-Congo, northern Equateur, and Orientale. Limited production occurs in Bandundu, Maniema, northern Kasaï, and South and North Kivu (GDRC, 2010). Cocoa cultivation in North Kivu is new, and growing. At the end of the 20th century, after coffee wilt disease destroyed 80 percent of the coffee crop, cocoa was successfully introduced to this province.

[23] Yields of a ton in Vietnam cited in the De Beule, Jassogne, and van Asten document may be an overstatement. Further, considerable advantage in Vietnam derives from more recent cultivation of soils and lack of development of pest communities there.

Farmers of almost all crops in the DRC face challenges such as exhausted soil, low-productivity plant material, and limited technical assistance.[24] Yet some factors raise marketing costs and lower returns for tree crop farmers specifically. Low and scattered production combined with inefficient transportation increase the expense of aggregating produce; sub-standard processing and phytosanitary systems lower quality and value; and informal and formal taxes eat into returns. Cocoa also competes with oil palm and non-agricultural activities (such as artisanal mining) for family labor (GDRC, 2010). In fact, De Beule, Jassogne, and van Asten (2014), present figures from Bandundu Province that indicate a much lower net profit margin per ha from cocoa cultivation than from either maize or cassava cultivation.

The country nevertheless has a proven agro-ecological suitability, and given the right conditions, can promote increased production. According to the government's CAADP New Partnership for Africa's Development (NEPAD) brief, Equateur province currently leads the country in production, and conditions in the Sankuru district in Eastern Kasai are particularly suitable for growth (GDRC, 2013). Plantations were once productive in portions of the provinces of Bas Congo, Bandundu, Equatorial, and Oriental. (Greater detail is in De Beule, Jassogne, and van Asten, 2014.) Considering access, as well as demonstrated agro-ecological suitability, some agricultural experts argue that the Mai-Ndombe District (Bandundu Province) and Tshopo District (Orientale Province) demonstrate the most potential for rejuvenation, reintroduction, and growth (assessment interview, Huart). A recent field study for Climate Change, Agriculture, and Food Security (CCAFS) (De Beule, Jassogne, and van Asten, 2014) identifies areas surrounding Mambasa in Oriental Province as having greatest potential for expansion, due to in-migration from the Butembo–Lubero region, quality of the road network, presence of a buyer who provides extension services, and support of the Wildlife Conservation Society (WCS) via distribution of planting materials. While some migrants to this area provide only labor, others are businessmen who buy, clear, and plant forested lands. The local requirement that land must be put to use to assert rights helps drive these sales and land conversion. The CCAFS study identifies the area with second greatest potential for expansion as that around Mbandaka and Lukolela in Equatorial Province. In contrast to increased production in Oriental Province, a large portion of growth there would be based on restoration of old fields. The area's remote location would require transport of produce by river. The study also suggests that in a post-conflict context, growth could occur within areas along the N4 and the Watalinga–Nobili area bordering the Virunga National Park. In all, the CCAFS study projects an expansion of between 17,625 and 39,550 ha nationally over the next decade. Although the CCAFS paper describes some of the growth it envisions as restoration of plantations, it depicts all of this expansion as "forest loss."

Reviving existing plantations could present a significant opportunity for diverting agricultural expansion away from forests (as described in the ProLand SI Working Paper). In one effort to support this type of growth, from 2010 to 2012, the Belgian NGO Trias worked to increase producer income in Bandundu province through support for creation of cooperatives (Trias, n.d.). In addition to providing technical training, Trias worked with cooperatives to establish a relationship with an international buyer, the Belgium-based international Puratos, which offered a stable market and price. Given the old tree stock, exhausted soil, and lack of inputs, production levels were understandably low (De Beule, Jassogne, and van Asten, 2014; Agriterra, 2011). Without such direct and ongoing support, in the now less accessible areas of many former plantations, such growth would likely not be intensive, as cultivation of cocoa in a more land-intensive manner requires extension services and fertilizer inputs—both largely unavailable to the remote forested areas of the DRC. In fact, intensification of cocoa production is still largely absent in Africa in general, except in Ghana, where the government has supported use of fertilizer (De Beule, Jassogne, and van Asten, 2014).

Given the current state of the cocoa industry in the DRC, large-scale growth would require significant changes in the overall enabling context, including infrastructure improvements, changes in government policy and technical support, access to upgraded plant stock, and a more favorable business climate. Without those changes, increased production in the cocoa sector might come either from gradual increases in the old

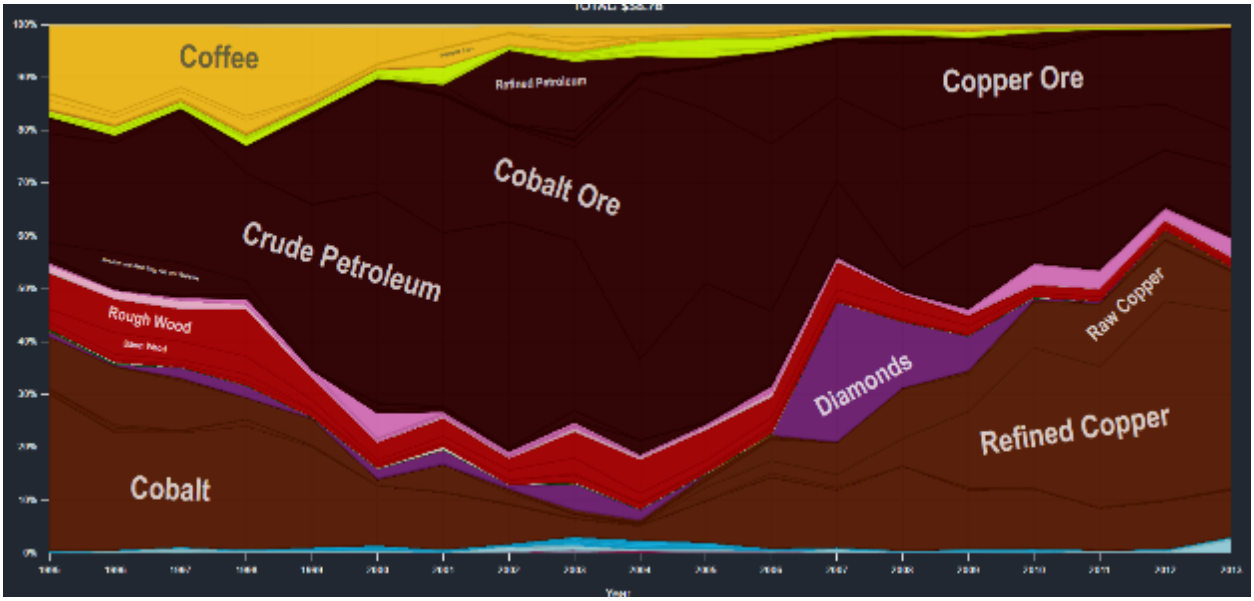
[24] Regarding perennials, both the plants themselves and the genetic stock are older.

plantation zones that are now relatively accessible or from cultivation in forested areas more accessible to markets, technical assistance, and inputs. We consider the latter in Chapter 5.0.

Coffee

The history of coffee in DRC and characteristics of the crop resemble those of cocoa in many ways. Efforts to increase production of these crops confront many of the same barriers. Like cocoa, coffee production in the DRC has declined dramatically since the 1980s. Exact figures are hard to come by. The FAO reports a decline from 91,000 MT in 1976 to 31,000 MT in 2013 (FAOSTAT 2011). The International Coffee Organization reports a historical high of 130,000 MT per year in the mid-1980s and a much lower official export rate of about 8,000 MT today. The MIT Observatory of Economic Complexity has created a visual representation of the drop in coffee export value relative to other exports (Figure 4.3 below). The official estimate of current production is 63,000 metric tons per year (International Coffee Organization Blog n.d.). The DRC produces coffee primarily in the highlands along its eastern border. Fertile soils, altitude, and climate of these eastern highlands are ideal for cultivation of Arabica coffee of exceptional quality. Coffee is produced in South Kivu (in Fizi Territory), in North Kivu (Beni and Rutshuru), and Maniema (Kibombo, Pangi, Punia, and Kabambare Lubutu) (GDRC, 2013). Much of the discrepancy between production and export figures traces to illicit export by farmers of a large percentage of the crop in response to constraints in the DRC business context, particularly the high rate of taxation. Experts estimate that because of taxes, bureaucratic delays, and cost of transit, costs of coffee production are $500 per MT higher in the DRC than in Uganda (interview, Schluter). Chapter 5.0 describes recent attempts to overcome these constraints and raise local production and incomes with minimal impacts on the country's forests.

Figure 4.3. Dramatic Decline in Coffee Exports: Share of Exports from the DRC 1995-2013



Changes in percentage value of exports, 1995-2013.

Source: The Observatory of Economic Complexity
http://atlas.media.mit.edu/en/visualize/stacked/hs92/export/cod/all/show/1995.2013/

4.1.6 AGRICULTURE IN THE REDD+ STRATEGY

Agriculture is the first component or "pillar" of DRC's REDD Strategy. The strategy recognizes need for agricultural growth and constraints posed by the current context. It describes the sector's potential to support economic growth, as well as its threat to the country's forests. In terms of concrete actions, the strategy highlights development of agro-industry as an important priority for the country, and foresees large-scale

commercial cultivation (presumably of annual crops) on the savannas, and production of perennials on plantations in the humid forest regions. It identifies investment in perennial tree crops (particularly palm oil and cacao) as an opportunity, noting tapering off of production elsewhere in Africa. The plan presents investment in these crops as a means of stabilizing swidden agriculture and mitigating its impacts on forests. It also identifies swidden agriculture (*agriculture itinérante sur brulis*) as the principal direct cause of deforestation, and cautions against the "rebound effect" (*l'effet rebond)*—potential for agricultural intensification to attract investment in agriculture and provoke increased deforestation. The objective for the component is agricultural growth with minimal impact on the environment.

The REDD+ strategy proposes four main activities for the agriculture sector. The first is to engage in a public process to guide how and where large-scale industrial and plantation agriculture will occur. This component also includes encouraging environmental certification. The second component is to promote legal and regulatory reform to facilitate decentralization and empowerment at sub-national levels. This also includes all other legal and regulatory reforms necessary to enable the country's institutions and organizations to promote sustainable agriculture. The third component consists of rural land use planning to direct agricultural investment toward degraded lands, establish zones for future needs of small-scale producers, and account for existing concessions. It includes participatory micro-zoning in rural areas to control expansion of swidden agriculture into forests. The fourth component focuses on building institutional and human capacity in the public and private sectors to support and implement these reforms. Concretely, the strategy proposes to increase agricultural production while mitigating impacts on the country's forests by intensifying swidden agriculture, promoting large-scale agriculture on the savanna, introducing modern agricultural methods, and developing perennial crops on existing underused plantation lands in the forest zones.

From the perspective of this assessment of agricultural intensification and deforestation in the DRC, the strategy raises two questions. The first concerns reliance on participatory micro-zoning as the sole means to reduce the rate at which small-scale farmers clear primary forest. Not only is zoning at the micro level an enormous task, especially in a country that has not moved forward on a national land use plan despite longstanding commitments to do so, but the strategy does not explain how planning itself will slow deforestation once the zones are created. The strategy includes changing land tenure and revising agricultural policy, but how these reforms, which will take decades, will reinforce the micro-zones or otherwise provide incentives to protect forests is not clear. This leads to the second concern regarding the DRC REDD+ strategy. In a manner that reflects the PNIA, rather than proposing intensification of smallholder agriculture, the REDD+ strategy emphasizes fostering large-scale, agro-industrial enterprises. Not only is this a very indirect approach to slowing the country's principal cause of deforestation (swidden agriculture), it foregoes the possibility of drawing on resources and energy of millions of producers (as noted in AfricaLead, 2014). State promotion of a capital-intensive, highly mechanized approach to agricultural intensification will remain exceptional, geographically constrained, and dependent on state funding until reforms alleviate the country's significant constraints on private-sector investment. The specified approach would leave the majority of the country's population unengaged and unchanged. As noted in another recent review of the DRC REDD+ strategy, empowering smallholder farmers and providing them the means to intensify their agricultural systems may more effectively reduce the threat to deforestation than emphasis on agribusiness models which, if they attract investment, pose risk of greater and poorly managed expansion. Improving the context for smallholder agriculture intensification will certainly more directly improve food security and broad-based economic growth (Pollini, 2014).

4.2 THE FOREST SECTOR

How to counterbalance potential impacts of agricultural intensification on forests depends on characteristics of the forest sector. This section overviews the three main forest sub-sectors in DRC: industrial logging, artisanal logging, and wood fuels. This section also identifies opportunities for CBNRM of forests in each sub-sector as a mechanism to counterbalance pressures that agricultural intensification exerts on forested lands. Active CBNRM initiatives in DRC are so recent that we describe them in the next chapter on ongoing

initiatives rather than as case studies for identified opportunities. A review of the legal basis for CBNRM in DRC in the *Ministère de l'Environnent et Développement Durable* (MEDD) Ministerial Arrêté No 025 of February 9, 2016, appears in this section; and this section concludes with a review of forest management approaches in the context of the REDD+ strategy.

4.2.1 OVERVIEW

Contribution of wood products to the economy: Current total value of production of the industrial, artisanal, and wood energy sectors in DRC is around $1.2 billion[25], without counting the value of non-timber forest products (NTFP) and environmental services provided by forests. The sum of all added value generated by all production units of an economy equals total production of the country, its national income measured as GDP. However, the officially registered GDP generally ignores products not sold on the market but consumed directly by producers. Moreover, added value generated by products sold via informal markets is not completely ignored but often underestimated in calculation of GDP (Forests Monitor 2007). These two flaws in official GDP calculations explain why the GDP of the DRC was estimated at US $762 million in 2005 (Debroux et al., 2007), while the estimated added value generated by the three sectors exceeds this figure by a factor of about 1.6. Contribution of the formal timber sector to the GDP of the DRC is about 5 percent.

Forest governance and institutions: Forest law enforcement is almost nonexistent due to lack of commitment by the financial and human resources that would be needed. The Department for Internal Supervision and Verification (DCVI), responsible for policing the sector, has limited financial resources and a very low level of human resources—this despite years of effort and multiple investments to increase institutional capacity in the forest sector and to improve forest governance by Forest Law Enforcement, Governance and Trade (FLEGT) with assistance by the World Bank, Canadian International Development Agency (CIDA), the European Union (EU), USAID, and others. Many taxes are created and collected by the army, police, and other parts of the government without legal or regulatory bases. The Forest Code mandates distribution of 40 percent of area taxes to provinces (25 percent) and territories (15 percent), but very little reaches these local government bodies (Réseau Ressources Naturelles. 2012).

Legal Categories of Forest Land. All forest land in the DRC belongs to the State, but because no map of state forest lands has been formally recognized by the government, the legal status of forest is open to dispute. The 2002 Forest Code defines three legal categories of forest, literal translations of which are Protected Forest, Classified Forest, and Permanent Production Forests. However, meanings of these categories are not intuitive. Protected Forest is natural forest on customary community lands, the least protected of the three categories. The other two categories are gazetted forests that have been withdrawn from the Protected Forest category though use of legal instruments. Classified Forests are what are commonly called Protected Areas (PAs), a term that covers several different types of PA. Permanent Production Forest consists of logging concessions already attributed to industrial logging companies or planned for that. Forests to be attributed to communities as concessions under the new forest law would fall under this category. The Forest Code allows for designation of non-forested lands as lands to be converted to forest lands. A future national land use planning exercise will change areas designated as Permanent Production Forests.

4.2.2 FORMAL TIMBER SUB-SECTOR

The formal timber sub-sector, also known as industrial logging, is not nearly as important in the DRC as formerly, and is not considered a significant direct cause of carbon emissions. At independence, 150 logging companies were active in the DRC (Mola Motya, interview). Following the 2003 conclusion of the most recent civil war, and under pressure from the donor community, the government issued a moratorium on new logging concessions that remains in place today. Lifting the moratorium is contingent on preparation of a national land use plan, but preparation of this plan has not yet begun. A major review of the logging concessions was completed in 2009. As a result of this review, 91 out of 156 logging contracts under review

[25] This figure is derived by summing totals of the sub-sectors, as cited elsewhere in the document.

were cancelled (Global Witness, 2012, n.d.). Only about a dozen companies remain in operation (Forests Monitor, 2007) and the *Fédération des Industriels du Bois* (FIB) claims that only five of those are very active (Mola Motya, interview).

These remaining concessions currently pose less threat to DRC's forests than do most other causes of deforestation and forest degradation. Logging operations primarily impact forest loss through secondary effects of logging access roads that provide forest access to commercial bushmeat hunters and small-scale farmers who typically clear fields on both sides of the roads. This clearing is not legal, but companies and the government rarely enforce the rules.

According to the Center for International Forestry Research (CIFOR), annual harvest of roundwood by the industrial sector has never surpassed 400,000 m^3 (Lescuyer, 2014). Most sources cite 300,000 m^3 as the typical annual harvest. Although DRC has over half of the rainforest in the Congo Basin, it produces only 300,000 out of the total 8 million m^3 harvested by the industrial sector in the entire basin. Logging concessions in the country are concentrated along the Congo River upstream from Kinshasa. Most timber from the formal sector leaves through Kinshasa, arriving by river (Debroux et al., 2007). Most timber produced in the sub-sector is exported in the form of logs. A smaller part is processed into sawn wood.

Certification is the main way to document sustainable and legal production of wood products. Two forms of certification have been, or are being, attempted in DRC—certification of good forest stewardship under the Forest Stewardship Council (FSC) system and certification of legally produced logs or lumber that meets the criteria of Forest Law Enforcement, Governance and Trade (FLEGT). No logging concession in DRC is certified under the FSC system. Société de Développement Forestier (SODEFOR), with WWF's assistance, may be close to attaining certification for legal production of industrial saw timber and thereby meeting requirements under FLEGT (Mola Motya, interview).

DRC's industrial timber exports are destined primarily for the European market, although China's share has grown substantially in recent years and includes timber harvested under ACPs (discussed below). The state is able to collect taxes from this sector relatively easily because taxes are based on export volumes and the area of concessions under production, both of which can be verified (Debroux et al., 2007; cited by Lescuyer et al., 2014).

Opportunities for CBNRM in the formal timber sub-sector

Co-management agreements between logging companies and local communities in logging concessions would benefit both parties. In the highly diverse rain forests of the Congo Basin, commercial logging companies usually harvest only about 13 species for export (Doetinchem et al., 2016). A larger number of species can be sold in national markets. Under co-management systems, community co-managers could exploit species marketable only in national markets using chainsaws or portable sawmills. Where households have illegally cleared farms inside logging concessions, farmers could be integrated into the co-management systems in return for abandoning their cropland or restricting crops to small areas zoned for this purpose. In return for their co-management rights, community co-managers could be required to undertake non-commercial thinning to release at least a minimum number of stems of the natural regeneration of high-valued species for both the export market (for the industrial concession holder) and for benefit of the species they are authorized to harvest for the national markets. This would be a self-financing management intervention to ensure adequate regeneration of commercial timber species.

Community-based management of wildlife for sustainable bushmeat may also be viable within industrial logging concessions. There is no biological reason why wildlife should not be abundant in logging concessions. Those who hold traditional hunting rights could be empowered under the condition that they not target protected species and that they report any unauthorized incursions into the concession to the forestry department and to the concession holder. This local monitoring may deter intensive commercial

poaching. Legal conditions specifying rights and obligations of the concession holder, community wildlife managers, and the forest department must be established.

4.2.3 ARTISANAL LOGGING SUB-SECTOR

Artisanal logging in the DRC could contribute positively to the country's economy, livelihoods, and sustainable forest management. In its current state, however, the artisanal logging sector has been so mismanaged that it contributes to degradation of forests. Artisanal timber production is defined as a series of operations, with or without permits, by individual small-scale millers whose main purpose is to supply sawn wood to the domestic market (Benneker, 2013). Artisanal logging should not be confused with fraudulent delivery of ACPs for industrial logging. None of the studies reviewed for this assessment includes estimates of quantities of sawlogs harvested under fraudulently issued ACPs.

Legislation governing ACPs in the DRC dates back to the 1940s, and at the time was an innovative measure to grant individuals at the community level rights for commercial harvest of saw timber trees for local markets (Lescuyer et al., 2014). Today, this sector, which mainly operates in forests near access routes, provides jobs and income to its rural workers, offers inexpensive products to the urban consumer, and thus could complement the industrial sector (Lescuyer, Cerutti, and Robiglio, 2013). In theory, artisanal logging always involves processing of saw logs in the forest and exerts much lower environmental impacts than industrial logging because it does not involve opening of access roads and use of heavy equipment for removal of logs from the forest. Currently, however, the artisanal logging sector in the DRC is poorly managed, politicized, and highly contentious. Legislation governing the sector is incomplete and inadequate, and government management of this sub-sector is dysfunctional and corrupt.

In particular, the system of allocating ACPs has been so abused that it no longer serves its original purpose. This mismanagement has resulted in such rapid growth of artisanal logging that it now much exceeds industrial logging. CIFOR conducted a year-long survey to monitor domestic artisanal timber markets in Kinshasa and Kisangani, and the main passage points for entry and exit of timber to/from Kinshasa, Kisangani, and six cities in the east of the country (Lescuyer et al., 2014). National annual production indicated by the survey now exceeds 1 million m^3 of chainsaw-milled lumber, of which 85 percent is for the domestic market. The rest of the lumber is for export to neighboring countries. The 1 million m^3 of chainsaw-milled lumber represents harvest of an estimated at 3.4 million m^3 per year in roundwood equivalents (RWE)—13 times more than all timber produced in the formal industrial sub-sector (Lescuyer, Cerutti, and Robiglio 2013). Small-scale production of saw timber is estimated to have doubled within the past 20 years. Small-scale loggers supply the domestic market with timber for construction or furniture, but they also export wood and wood-based products to neighboring countries, particularly Uganda, Angola, Burundi, Rwanda, and Zambia.

Governance of the artisanal sector has been complicated by an incomplete legal framework, particularly by lack of legal texts regarding community forestry. Because of this legal vacuum, artisanal loggers lack recognition and are forced to operate largely outside the legal framework. At the same time, government authorities have illegally issued ACPs to users who should not be authorized. By law, ACPs authorize only small-scale operations in which Congolese or small businesses owned by Congolese use manual pit saws or chainsaws to produce saw timber. Only provincial governors and MEDD provincial-level coordination offices have the right to issue ACPs. Benneker (2013) indicates that the central MEDD office has issued ACPs for industrial-scale use. Other entities that illegally issue permits for artisanal logging include provincial ministries of environment, land administrators, and district officers. The ongoing process of decentralization has created confusion over mandates and responsibilities, and opened opportunities for abuse. The Coalition against the Illegal Cutting of Wood estimates that only 40,000 m^3 of artisanal wood is harvested under legally delivered ACPs. Most of the industrial harvest of saw timber conducted under illegal issuance of ACPs is localized in Bandundu Province upstream from Kinshasa (Lescuyer et al., 2014). Sale of products resulting from ACPs supposedly is restricted to national markets. In practice, ACPs are frequently issued to industrial-scale companies, including those owned by foreigners, and are used to produce logs and lumber for the export market. ACPs have also been allocated for logging protected species at both industrial and artisanal

scales. Global Witness and Greenpeace have exposed this illegal cutting. Between 2010 and 2012, dozens of Artisanal Logging Permits were allocated, mostly to foreign industrial companies, violating DRC's forest laws in at least 10 different ways (Global Witness 2013). Almost no controls of use of the permit in the field are in place, and communities receive nothing. Illegal logging around Bandundu had been reduced from its previous levels by 2012 but remained a major problem (Global Witness, 2012).

A study conducted by WCS in northeastern DRC found the artisanal logging sector characterized by 1) lack of clear regulations; 2) corruption by political and military elite; 3) low capacity of Forestry Department staff and loggers; 4) lack of contribution to community development; 5) opportunistic, unprofessional, and illegal logging; 6) lack of environmental soundness; and 7) lack of reliable statistics concerning the volume of exploitation occurring. Most artisanal loggers and traders are not local. Artisanal loggers range from a few individuals who join together to harvest timber 2 or 3 months a year, to permanent enterprises with a dozen or more regular employees. Most small-scale loggers can be classified as belonging to the informal sector because they operate without ACPs. Most true, small-scale, artisanal saw milling today utilizes chain saws, not pit saws. Chainsaw millers usually target a relatively limited number of species, including species of export quality that are also targeted by the industrial sector. Chainsaw millers also typically target large-diameter trees. All of this certainly represents a "high-grading" form of forest degradation that leaves the forest with fewer trees of high value.

Opportunities for CBNRM in the artisanal logging subsector

Benneker (2013) argues that, in spite of its very negative reputation, artisanal logging could play very different roles in DRC. A probably safe assumption is that most artisanal loggers exploit forests in areas where this is most profitable—a strong indicator as well of where CBNFM can be most profitable. Areas targeted by artisanal loggers should be prime candidates for development of community-based humid forest management focusing on production of saw timber. Formalization through CBNFM could put artisanal logging on a sustainable footing and increase profitability for communities, increasing their incentives to conserve the forest rather than integrating it into the swidden system of fields and fallow. Artisanal logging correlates strongly with access, and is concentrated mostly within about 2 km of road or water transport. Artisanal loggers work in unmanaged forests, selectively targeting the higher value trees, thereby "high grading" and decreasing the value of forest stock. The practice currently generates very significant income for small businesses and for communities and traditional authorities.

Small-scale artisanal loggers typically negotiate with local communities or traditional chiefs for rights to harvest designated trees. Benneker (2013) cites an example in which the logger agreed to pay $30 to $50/tree depending on size. Considering both rural and urban zones, the small-scale chainsaw milling sector accounts for at least 25,000 full and part-time direct jobs in DRC. The CIFOR study found that chainsaw milling generates net annual revenue of about US $111 million, with net revenues divided among four categories of people, as listed in Table 3 (Lescuyer et al., 2014):

Table 3. Net revenue from chainsaw milling (Lescuyer et al., 2014)

Category of Actors	Revenue (percent)
Rural populations	51.8
Private sector	46.8
Administrations	9.8
Urban populations	2.6

The figures in Table 3 demonstrate that artisanal logging could contribute significantly to profitable forest management, with very significant benefits for communities, if integrated into CBNFM on a sustainable basis and, especially, if community members develop the skills to become artisanal loggers. In 2008 and 2009, WCS attempted to do this by supporting a participatory process to draft new provincial legislation for community-based natural forest management, and helping to prepare a draft forest management plan for 42,500 ha of the

Banana CBNRM macro-zone near Mombasa before insecurity returned to the area (Brown and Makana, n.d.). Security issues currently impede WCS from working with communities outside of the Okapi Faunal Reserve.

Artisanal logging generates very significant income for artisanal small businesses and communities. Good potential seems evident for integration of artisanal logging into CBNFM under simplified forest management plans that ensure sustainability and substantial benefits for communities and their members. As with the formal industrial logging sector, selective harvest of trees by small-scale artisanal loggers probably exerts relatively little impact on carbon stocks.

4.2.4 WOOD FUELS SUB-SECTOR

Debroux et al. (2007) estimated fuel wood harvest for both rural and urban use in DRC at 72 million m^3 per year, with value of over 1 billion USD—approximately 240 times greater than the 300,000 m^3 of wood harvested legally and annually by industrial logging sector, and 21 times the 3.4 million m^3 that CIFOR estimates is harvested by small-scale artisanal loggers. Doetinchem et al. (2016) estimate that an average of 1 m^3 of wood is harvested annually per person in the Congo Basin. The REDD+ National Strategy (GDRC, n.d.) uses the figure of 50,000 m^3 for total wood fuels harvest. Most wood fuels in rural areas are harvested from dead wood or from wood cleared from fallows as part of the normal swidden cycle, and both of these uses exert little impact on forest carbon stocks. Nearly all rural households and most urban households use fuel wood or charcoal for cooking. In fact, wood energy accounts for 80 per cent of all domestic energy consumed in the DRC (Forests Monitor, 2007).

The charcoal supply zone extends 400 km by road from Kinshasa. An estimated 23 percent of charcoal consumed in the City enters via the Congo River from provinces of Bandundu, Equateur, and Orientale up to 1000 km away, demonstrating the relatively low cost of transport of materials by water. While the formal forest sector employs 15,000 people (Eba'a Atyi and Bayol, 2009), more than 300,000 people work in informal wood fuel production for Kinshasa alone (Schure et al., 2011). Production of 76 percent of wood fuel for Kinshasa and Kisangani occurs in conjunction with clearing of fields for swidden agriculture. For Kinshasa alone, approximately 24 percent of wood fuel comes from forests (generally degraded forest along rivers in the supply zone of Kinshasa, 39 percent comes from clearing of swidden fallows, and 37 percent comes from new clearing of forests to create swidden fields (Ingram, 2013). Every available tree species is used to make charcoal in the Kinshasa supply zone. This includes young trees of species suitable for saw timber for the export market. To date, reforestation by private-sector investors and by villagers for wood fuels production has been insignificant, and has occurred only when subsidized by donors (see the discussion on Mampu and Ibi Village agroforestry systems in the next chapter). Permits cover only a small percentage of harvested wood fuel in DRC. Access to wood from forest lands is generally governed by customary rules. For commercial operations, access is commonly gained through customary land rights, by renting land, or by buying trees from the landowner or village chief. Only 3.5 percent of producers own an official forest concession. Despite the total retail value of the final product, income of wood fuel producers remains low, with over half earning less than US $50 per month.

Harvesting of wood fuels has combined with other non-sustainable practices to severely degrade large portions of the DRC. Over-harvesting of wood fuels, in conjunction with short-fallow swidden and uncontrolled burning has resulted in exhausted soils, progressive replacement of wooded fallows by grass fallows, and near total replacement of rain forests with grasslands within 50 km of Kinshasa (Doetinchem et al., 2016).

Opportunities for CBNRM in the Wood Fuels Sub-Sector

Charcoal supply zones for urban centers may offer the best opportunity for development of profitable, intensive CBNFM. The International Tropical Timber Organization estimated that 4.3 million m^3 of wood was used to produce the charcoal and fuelwood traded in Kinshasa in 2010 (Schure et al., 2011). Households depend largely on wood fuels for daily cooking (87 percent in Kinshasa and 95 percent in Kisangani).

Businesses, such as bakeries, breweries, restaurants, brick makers, and aluminum forgers, also depend on fuel wood or charcoal for their daily operations. In Kinshasa, total charcoal market value was estimated at US $143 million in 2010—3.1 times the value of the country's national timber export ($46 million in 2010) (FAOSTAT, 2011). This could be a major additional source of sustainable revenues for communities from forest management if CBNFM would be developed within urban charcoal supply zones and if forest management systems would include production of wood fuels.

High potential of these charcoal supply zones derives from great demand, low transport costs, and markets for species that cannot be marketed as saw timber. Degraded forests in the charcoal supply zones could be managed for generation of sawtimber and the full range of other wood and non-wood products. Low-valued trees could be removed for wood fuels during periodic thinning, leaving the managed forest rich in high-value sawtimber species.

A major barrier to implementation of this approach is frequent control by armed groups of the charcoal trade within conflict zones in eastern DRC. Emmanuel de Merode, director of Virunga National Park, has reported that "All the armed groups, including the FDLR (*Forces démocratiques pour la liberation du Rwanda*), and some individuals in the army are implicated in the traffic of makala [charcoal]…. Illegal trade in makala generates up to US $30 million per year. A large proportion of this money goes to the armed groups." (Environmental Resources Information Network [ERIN], 2016). Even in areas free of conflict, multiple payments of "informal" taxes are commonly imposed on those transporting charcoal to urban centers.

4.2.5 LEGAL FRAMEWORK FOR COMMUNITY-BASED NATURAL RESOURCE MANAGEMENT

One of the biggest restraints to CBNRM has been lack of specific legislation for empowerment of communities to manage forest, wildlife, and fisheries resources. The 2002 Forest Law allowed creation of community forest concessions, but 14 years passed before development and passage of regulations to render this operable. A decree was passed in August 2014, but this still needed a final "arrêté" for application of it. MEDD Ministerial Arrêté No 025 was published on February 9, 2016 (presented in Annex F). As typical of laws and regulations developed in the absence of tested and proven pilot initiatives for CBNRM, the new regulations are full of clauses that will constrain its usefulness.

Analysis the new arrêté according to the principles of successful CBNRM conveyed in Chapter 2 reveals a mix of strengths and weaknesses. Among its strengths is clear authorization for communities to manage their forest concessions for saw timber—probably the highest valued product. All adult members of the community are to be members of the general assembly, avoiding control by a single user group. However, the arrêté's weaknesses listed as follows are far more numerous:

- Tenurial:
  - No language explicitly requires that concession boundaries be based on traditional tenure rights.
  - Exclusivity of rights for the community is not clear. Rights and obligations are not clearly spelled out. Empowerment should be conditional upon such factors as sustainable use, non-conversion to other land uses, and no hunting of protected species, but these are not specified.
- Management:
  - No allowance appears for multiple use management such as managing a forest concurrently for saw timber, poles, wood fuels, NTFP, wildlife, and biodiversity. This will severely constrain profitability of CBNFM.
  - All authorized uses of community forest concessions must be exercised as unique, single uses in portions of the concession zoned, respectively, for specific uses.

- No mechanism is specified for funding management costs (normally, management costs should be covered out of revenues).

- Sustainability:
  - No direct language requires sustainable use of forest resources.
  - No statement appears forbidding conversion of the concession to agriculture. Indeed, the language seems to require the community to practice agroforestry in some parts of the concession—a very dangerous practice that can result in forest clearing and establishment of traditional tenure rights for those who raise crops in the concession.
- Governance:
  - The non-elected (and possibly non-accountable) community chief is made responsible for good governance. Communities are not required to develop a specific plan for equitable sharing of costs and benefits.

Table 4 more completely analyzes specific articles of the arrêté.

Table 4. Arrêté No 025

Article	Analysis
Article 5: Internal organization must include: 1. General assembly 2. Management Committee 3. Control and M&E Committee 4. Council of the Wise (or Elders?)	This is a very heavy and cumbersome set of structures. A global review of CBNFM recommended use of existing community structures whenever possible (Hagen, 2014).
Article 7: All adults are members of the General Assembly	This is very good. CBNRM should not be controlled by single user groups.
Article 9: The forest management committee will also be responsible for the community development fund.	These require different types of expertise. A forest management fund is really needed. Forest managed for conservation will not necessarily generate any revenues for community development.
Article 20: et 21 The customary chief is responsible for good governance of the concession.	What if the chief is corrupt? Article 21 says the chief cannot take revenues for himself, but specifies no safeguards to prevent this?
Article 23: The concession must be zoned for specific purposes.	Multiple use management is very common in forestry. Zoning for single uses can cause major losses of revenues.
Article 24: For saw timber production zones, trees to be harvested and those to be protected must be laid out on a sketch map. The volume to be harvested each year is to be specified.	Marking out locations of the trees is a good idea. It can occur accurately by use of a Global Positioning System (GPS). Specifying annual quotas is not necessarily the best way to control amounts harvested. The best silvicultural practices are not based on quotas.
Article 26: Makes allowance for annual revisions to the simplified management plan.	If done in a participatory manner, this is equivalent to adaptive management. This is very important in early years of development of new CBNFM systems.
Article 28: Four copies of the simplified management plan must be submitted for approval.	How will such copies be made? Are photocopiers and electricity available at each local forestry office?
Article 32: Once approved, the community has the obligation to implement the simplified management plan.	This is a very rigid position. Markets fluctuate continuously. Communities should not be forced to harvest when market prices are too low.
Article 34: Communities can exploit their concessions themselves and they can contract with artisanal businesses to do the harvest.	This freedom of choice is very good.
Article 41: Communities that harvest saw timber	No indication of the amount of the tax appears.

Article	Analysis
themselves must get a permit from the forest department and must pay a tax.	
Article 47: Saw timber may be produced in a community concession only by uses of chainsaws, two-man manual saws, and winches (tir-fort).	This is exactly the opposite of what efficient wood processing would require. Chainsaw milling is very wasteful compared to milling with portable band saws. This regulation is the exact opposite of what should be promoted.
Article 52: Wood fuels can be produced only from forest blocks zoned for the purpose.	This is completely contrary to good forestry. This means that one cannot practice good silvicultural thinnings, cutting out low-value stems for firewood and retaining high-value stems for poles and saw timber. This would greatly decrease the value of the forest for communities.
Articles 55 & 56: Hunting and fishing in community concessions must occur with strict respect of existing legislation. Hunting and fishing can occur only in specific zones dedicated to the purpose.	Again, this is very bad practice. Wildlife management is biologically compatible with all other forest uses. Dedicating forests to hunting will greatly reduce the value and profitability of the forest for communities.
Article 59: Community managers are held to promote the practice of agroforestry in their concessions.	Agroforestry is a form of agriculture and the last thing one should promote in a forestry concession. Agriculture brings with it creation of individual tenure rights. Most forms of agroforestry would involve destruction of all or most of the natural forest. This can exert serious negative impacts on soil fertility, biodiversity, and carbon stocks.
Article 62: Each community with a concession must create a community development fund.	The regulations do not call for or authorize creation of a community forest management fund. Natural resource management entails costs that generate benefits. Nothing is said about how management costs will be covered. For example, the regulations call for non-commercial thinnings to release future crop trees, but do not specify how such interventions will be financed.
Article 63: The forest management committee will manage the community development fund.	Same as Article 9
Articles 65 and 66: Conservation and protection of biodiversity.	Biodiversity conservation and protection must occur only in special, dedicated zones. In practice, biodiversity conservation can be integrated into all forms of forest management cited in the legislation, except for agroforestry.
Articles 69 to 72: Two contiguous communities can manage their concessions together.	This would seem to exclude the type of two-tiered management structures that have been so successful in Burkina Faso over the past 30 years. The limit is two, and they have to be contiguous; no logical explanation appears for these restrictions.
Article 83: The local community chief must oversee adherence to legal obligations. He must signal any violations by members of the community to the forest service.	Under CBNFM, the community is usually responsible for policing itself. The community needs help dealing with violations by people from outside the community. How violations by outsiders will be handled under the new regulations is not specified.

4.2.6 FOREST MANAGEMENT IN THE REDD+ STRATEGY

Regarding carbon emissions, hindrances to quantification of carbon stock changes associated with degradation and regrowth have prevented accumulation of sufficient information to estimate the magnitude of GHG emissions from each sector. Estimated volumes to be extracted from each sub-sector may be indicative of carbon emissions, however—according to CIFOR estimates, fuel wood extraction could be 240 times greater than the 300,000 m^3 of wood harvested annually by the industrial logging sector, and 21 times the 3.4 million m^3 harvested by small-scale artisanal loggers. Because the emissions profile of fuel wood is much larger than wood going into wood products, wood fuels are likely by far to be largest direct source of GHG emissions from the forest sector.

The DRC's national REDD+ Strategy, as it concerns CBNRM and CBNFM, is assessed against the principles of successful CBNRM presented in Section IIC. Both Sections 3.3 (vision statement) and 3.4 (political engagement) cite need to develop local or community management of forests and natural resources. The second and third pillars of the REDD+ Strategy cover energy and forests, and both include measures related to natural forest management. The overwhelming importance of wood fuels for domestic energy is duly recognized in the second pillar on energy, but it does not develop a clear strategy for wood-based energies, let alone the role of natural forest management in production of wood fuels. Instead, the REDD+ Strategy calls for development of a national strategy for wood energy and for energy alternatives to wood.

The REDD+ Strategy targets the following four results for the energy sector, but only the second result obliquely touches on wood energy from natural forests:

1. Increased production of alternative energies other that wood energy.
2. Reduction in amount of wood energy harvested from natural forests, with this production rendered more sustainable.
3. Increase in production of wood energy from lands other than natural forest without threatening national food security.
4. Consumption of both wood energies and alternative energy rendered more efficient.

The third pillar of the REDD+ Strategy regards forests and is divided into sections on production forests, protected forests, and carbon sequestration within non-forested and severely degraded areas. The strategy is very positive about community-based natural forest management but recommendations are generic, and the Strategy displays relatively little knowledge about the principles of successful CBNFM.

The principles of successful CBNRM were applied to assess the REDD+ Strategy on forests. Positive and negative findings are summarized below.

On the positive side:

1. One of the main outcomes of the forest component is that local communities and indigenous people would become direct actors in forest management and would benefit from this.
2. Community management of forests is given high priority in the sub-strategies for production forests and for "conservation forests" (forests to be conserved primarily through protection).
3. Targeted as a priority action is development of ministerial regulations needed to render operational the 2002 Forest Code provision for community forest concessions (these regulations were passed on February 9, 2016).
4. Clearly, harvest of saw timber from community concessions is to be authorized. This is critical because saw timber will probably be the highest value forest product from most community forests, and must be included if community forest management is to compete with agriculture as a profitable land use.
5. For the "forêts protégées" or protected forests, need for control of artisanal logging is recognized in conjunction with transfer of management responsibility to local communities.
6. Participatory land use planning at the village level is proposed for specification of lands each community will set aside for agriculture, conservation, and sustainable forest management. (What is

meant by "conservation zones" is neither revealed explicitly nor clear, given that sustainable forest management is a form of forest conservation but seems not included in this category).

On the negative side:

7. At the time the strategy was completed in 2013, there was no recognition of lack of operational examples of CBNFM in DRC. Similarly, little recognition was evident that very few people in DRC have any experience or expertise in CBNRM.
8. No recognition was apparent of the time frame needed to design and test different forms of community-based natural resource management. Neither were recognitions evident of: a) difficulty in developing pilot initiatives on technical, economic, financial, socio-organizational, and cultural levels that would satisfy key stakeholders; and b) possibility of failure of a portion of the pilot efforts before development of a sound framework.
9. The strategy did not explicitly recognize that benefits (of all types) to communities and community members must significantly exceed costs (of all types) and obligations if CBNFM is to attain broad success.
10. No recognition was evident that economic realities of the market determine locally viable forms of CBNFM. Only forests within the charcoal or fuelwood supply zones for specific cities can be managed profitably for wood fuels. Even management for artisanal saw timber cannot proceed profitably in all places, but must occur within a reasonable distance (perhaps 2 or 3 km) from a road or navigable stream.
11. Articles 18 to 22 address community management and exploitation but are very generic. Little is said about specific mandates and responsibilities as to who would provide support for development of community management of forests.
12. Nothing is said about sustainable financing for CBNFM and how community management costs should be covered. Nothing is said about the importance of equitable sharing of benefits and costs of community management. The focus is exclusively on management for saw timber, and nothing is said about how wood fuels and saw timber can be integrated into forest management within urban supply zones.
13. Nothing is said about particular needs and opportunities for developing CBNFM within the charcoal supply zones of cities. The strategy indicates no recognition of the major opportunity for sequestration of large amounts of carbon by bringing heavily degraded natural forests under community management for production of wood fuels and saw timber.
14. Not recognized is the widespread potential of community-based management of wildlife to achieve sustainable production of bushmeat as a means of generating revenues, and to provide incentive for communities to conserve forests.
15. The REDD+ Strategy recognizes absence of technical or financial means to manage most of DRC's protected areas (*forêts classées*). This is a strong and pertinent observation, but no significant strategies are proposed to rectify this problem.
16. The REDD+ Strategy proposes development of co-management systems that integrate communities into protected area management, and calls for creation of community-managed "conservation" areas (essentially community-managed PAs); but little or no discussion appears regarding possible economic incentives for communities to manage or co-manage protected areas. The Strategy envisions increased benefits from PAs for the State and for communities, but provides no specifics on how to achieve this.
17. The strategy for afforestation or reforestation of areas outside of existing forests defines no specific role for communities, and is especially weak in its specification of incentives for afforestation and reforestation.

5.0 ONGOING PROGRAMS: AGRICULTURAL INTENSIFICATION AND THE MITIGATION OF FOREST LOSS

5.1 CARPE AND LAND USE PLANNING

5.1.1 REVIEW OF TREE COVER LOSS ON THE CARPE LANDSCAPES

Maps produced by WRI for this assessment provide an introduction to forest change in the seven USAID/CARPE-supported landscapes in the DRC. (See Maps G-7, G-8, G-9, G-10, G-11, G-12, and G-13.) Each map presents the landscape, protected areas, logging concessions, known artisanal logging permit sites, and locations of "carbon emissions," which, following the limitations described in Section IIIA2 above, basically represent areas of concentrated TCL weighted according to biomass density. Because the TCLs measured are primarily from expansion of swidden agriculture and recurrent cycles of clearing fallows, this map represents virtually the same patterns as the map of the rural complex produced by Molinario et al. (2014) (Map E-1 D). Table 5 roughly summarizes locations and extents of carbon emissions and rural complex in each CARPE Landscape.

Table 5. Locations of Rural Complex/Carbon Emissions in DRC CARPE Landscapes

Landscape	Protected Areas (PAs)	Logging Concessions	Rural Complex	Other Notes
Virunga	High	Not applicable (N/A)	High	No artisanal permits
Ituri-Epulu-Aru	Low	High	High	Concentrated along roads; few artisanal permits.
Maiko-Kahuzi-Tayna-Biega	Moderate	N/A	Moderate	No artisanal permits
Maringa-Lopori-Wamba	Moderate	Moderate, highest in SIFORCO	Moderate	Concentrated along roads; few artisanal permits
Salonga-Lukeni-Sankuru	Low	Low	Low	Hunting reserve and logging concessions overlap; a moderate number of artisanal permits
Lac Tele-Lac Tumba	Moderate, with isolated clearing	High	Moderate	Reserve and logging concession overlap; many artisanal permits

The maps produced by WRI display a number of features of forest change dynamics in the DRC. Most PAs in these landscapes should have very low rates of tree cover loss, represented here as carbon emissions, even without any efforts to protect them, given their remote locations. However, the maps show that almost all of them do have some level of carbon emissions, which we can assume stems from expansion of swidden agriculture. PAs closer to areas of high population density have undergone greater forest disturbance. The land areas outside the PAs have undergone a greater rate of tree cover loss, much of it in linear patterns as farmers create fields alongside roads and waterways, as can be seen with better clarity in the presentation of the rural complex on Map E-1. Carbon emissions are also quite high in many logging concessions in the landscapes, presumably due to agriculture "following" roads constructed for logging, absence of logging company capacity to prevent agriculture, or immigration into abandoned or inactive concessions. Significant overlap between logging concessions and PAs also reflects the government's inability to coordinate land use among ministries.

5.1.2 EFFECTIVENESS OF LAND USE PLANNING

Land Use Planning (LUP) is the main tool CARPE has used to attempt to manage tree cover loss in the landscapes. The principal emphasis of CARPE Phase II was macro-zoning of entire landscapes. The landscapes were categorized into macro-zones of three types: 1) protected area zones, 2) extractive use zones, and 3) CBNRM zones. In Phase III, emphasis has been on micro-zoning of village lands into agriculture and community forest zones.

Looking first at the macro-zoning of Phase II, in the context of this report, one of the first things that stands out is absence in the landscapes of zones explicitly dedicated to agriculture—the main economic activity for the people living in the landscapes. The category that comes the closest is CBNRM, but as the acronym implies, and explained earlier in this report, CBNRM refers to community-based management of natural resources such as forest, wildlife, fisheries, and perhaps community-protected areas. Ironically, while CARPE has promoted some agricultural growth within areas zoned in this category, no CBNRM has so far been implemented successfully.

The extractive use zones consist of industrial-scale logging concessions. Logging concessions existed well before CARPE, and they underwent a major review process supported by CARPE II. As a result of the review, the GDRC discontinued 90 concessions in 2009. It then reinstated a limited number shortly thereafter (Aeronautical Reconnaissance Coverage Geographic Information System [ARCGIS], 2012). While the focus of the review was to eliminate corruption in the industry, and not specifically to address zoning problems, it is nevertheless surprising that after such an extensive review and termination of such a large number of concessions, some remaining legal logging concessions overlap with the third macro-zone PAs. Despite CARPE participation in the process, examples of this failure in zoning occur within the Lac Tumba and Salonga landscapes. (See maps G-8 and G-12).

CARPE Phase III emphasized participatory micro-zoning at the village level of selected portions of landscapes zoned for CBNRM. Although described as micro-planning, the plans divide land use into only two general categories: agriculture and community forest. The former usually does not distinguish different types of agricultural land use, such as food crops, cash crops, tree crops, and agroforestry, thereby limiting its effectiveness as a planning tool. This may be attributed to CARPE IPs' focus more on using micro-zoning as a strategy to confine agriculture to the areas zoned for that purpose and to prevent any further clearing of community forest land for agriculture. (Of course, more focused participatory zoning of each village's agricultural zone could occur as needed if and when IPs invest in agricultural intensification.) In a similar manner, micro-zoning for the community forest category does not differentiate among various potential uses. Plans for this category just delineate the traditional boundaries of community forests. As a result, they also do not provide an effective foundation for productive use of the zones' resources. More detailed zoning would be necessary for sustainable management of forest for different products such as wood fuels, sawn wood products, and bushmeat.

As currently conceived and implemented, CARPE zoning activities do not substantially increase farmer incentives to stop the process of clearing the forests. Micro-zoning plans may eventually serve as a basis for further participatory village level land use planning for specific uses. But until then, the zones serve as a virtual, and likely ineffective, "fence" around community forests. They are based on agreements, sometimes with the backing of local officials, but with no weight in law. CARPE land use planning has no legal basis, and the plans produced are not legally recognized by the government. They are not even consistently incorporated into ministerial planning—the Department of Inventories and Forest Management in the MEDD has elected to use them, while the Ministry of Agriculture has not. As clear elsewhere in this assessment, even if the GDRC did adopt the CARPE zoning process as law, the weakness in the government's capacity to enforce the process would likely add CARPE's landscapes to the long list of unsuccessful "fences and fines" efforts across Africa and the world.

Opportunities for CBNRM in CARPE landscapes

Successfully subdividing community forest would require a preliminary process of piloting, evaluating, and refining various types of CBNRM systems to define approaches that are profitable and feasible under the widely varying ecological and socio-economic conditions encountered in the landscapes. For example, community-based intensive forest management that includes production of wood fuels can be conducted profitably only inside charcoal or fuelwood supply zones of urban centers. However, without mapping the limits of these supply zones, demand for wood fuels in different locations cannot be determined.

The best approaches for community-based forest management for production of sawn wood products also remains largely undefined. CBNRM for production of sawn wood products would certainly be profitable in areas much larger than the urban charcoal supply zones, but would still be restricted in other areas by poor access and the cost of transporting sawn wood products to the market. Community-based forest management for sustainable production of bushmeat could also be a profitable land use option, but efforts have not been undertaken to demonstrate or pilot this.

During the course of this study, discussions were held with AWF and WWF about their CBNRM strategies for managing community forests. The strategy they have adopted promotes collection of NTFP from community forests, but does not allow cutting trees for commercial purposes. The approach excludes agriculture within the forests. Collection of NTFP by local communities is a common practice in PAs in the DRC. Because communities already collect NTFP from their forests, this means that the IP vision for community forests would not likely generate any significant new benefits but would create new obligations and restrictions on their use. CARPE IPs have not yet developed profitable community-based natural forest management systems that create direct incentives for forest conservation in community forests. Absent an effective counterforce, farmers will likely continue to expand their holdings into the biodiverse, carbon-rich forests of the CARPE Landscapes.

5.2 ONGOING PROJECTS IN AGRICULTURE AND CBNRM

In a country as diverse as the DRC, no single approach can be adopted to limit the impact of agricultural growth on the country's forests. Some ongoing agriculture projects target "sparing" land by promoting alternatives to land-extensive swidden systems. Projects implement this approach in different ways on the forest edge, on older agricultural zones, and on sparsely populated lands of the savanna. Other agriculture projects support "sharing" land by promoting shade-grown cocoa and coffee cultivation. At the same time, some non-agricultural projects work to create incentives to counterbalance pressures on forests. Some, located in or near forests, target strengthening the capacity of communities to sustainably manage and generate revenue from natural forest products, such as timber and wildlife. Others, located near urban centers, support smallholder production of charcoal for urban markets. Studies of the impact of these projects on forest resources are few. To get a sense of the potential impact of these projects, we compare their approaches to outcomes of other projects, the principles identified in the ProLand SI Working Paper, and the CBNRM principles from the CARPE Phase II evaluation.

5.2.1 ONGOING PROJECTS IN AGRICULTURE

Illustrative projects designed to intensify agriculture near forests

USAID CARPE project IP AWF and consortium partners have implemented both "land sparing" and "land sharing" approaches to agricultural intensification in the forested areas of the Maringa-Lopori-Wamba landscape. International Center for Tropical Agriculture (CIAT) worked with AWF promoting a "land sparing" approach to intensification of staple crop cultivation from 2009 to 2013. In 2013, their work was taken over by IITA. As did CIAT, IITA works to introduce new varieties and field management practices. IITA collaborates with pilot farmers to conduct participatory trials, demonstrations, and evaluations to promote adoption by communities of higher yielding, disease- and pest-resistant varieties. IITA also promotes improved field management practices intended to control weeds and maintain soil fertility. The project strengthens the value chain by creating producer associations, building product warehouses and processing facilities, and improving access to markets. By 2014, over 150 village-level associations participated in the project activities. The most significant achievement has been large-scale adoption of different varieties of staple crops.

An assessment of the effect of CIAT's work reports great reluctance on the part of households to adopt the new practices. Women in particular were deterred due to the increased burden of weeding (Pollini, 2014). At the same time, farmers appear to have responded strongly to the strengthened value chains by increased planting (Yanggen, Angu, and Tchamou, 2010). We must assume that the farmers are either planting the improved varieties on newly cleared land or have shortened fallows. For its part, IITA has yet to evaluate the adoption rate of soil fertility and weed management practices, and is thus unable to provide evidence as to whether or not this intensification is "complete." Increased planting and high-yield varieties may be reducing soil fertility more quickly. Thus far, the "land sparing" effect of the project remains unclear. However, if AWF does succeed in promoting sustainable increases in yields that encourage greater investment in agriculture, their efforts are likely to increase expansion of local agriculture into the forest absent implementation of an effective system of sustainable forest management,.

The World Bank $130 million Agriculture Rehabilitation and Recovery Support Project, approved in 2010, also takes a "land sparing" approach, though at a much larger scale. The project consists of multiple smaller community activities intended to increase agricultural productivity and improve marketing of rainfed crops, small ruminants, and poultry in the Equateur province. (A second component supports irrigated rice on the outskirts of Kinshasa.) Thus far, the project has supported multiplication and dissemination of 1.5 thousand tons of commercial seeds, rehabilitated almost 2000 km of rural roads, and vaccinated over 3 million poultry and small ruminants. The project location north of the Congo River includes primary and secondary forest, savanna, and land already committed to agriculture. The social and environmental assessment prior to finalization of project design determined a number of mitigation practices to be undertaken. In recognition of potential impact of agricultural intensification and road rehabilitation, the assessment recommended environmental assessments for each specific activity, as well as reforestation, strategic placement of agricultural investments, and close impact monitoring (Doucouré, 2009). The Project Appraisal Document argues that poverty and low yields fuel agricultural expansion, and that by promoting intensification in this more degraded region, the project will "relieve pressure" on forests south of the river (World Bank, 2010).

The World Bank project design thus includes a number of strategies to mitigate impacts of agricultural intensification: targeting activities in agricultural areas away from forests, strengthening the enabling environment for capital-intensive smallholder agriculture, and closely monitoring impacts. Implementation will be important for determining effectiveness of these design features. No evaluation of the short-term impact of this project on forests has been made available. The long-term impact may in any case be more important: based on research findings conveyed in the ProLand SI Working paper, successful widespread intensification of agricultural systems in the project area likely will lead to expansion of farming to forested areas, especially within the project zone, because the project includes no measures to hinder such expansion through creation of incentives to protect forested areas.

Illustrative projects designed to intensify staple crop cultivation in Eastern DRC

Projects taking a "land sparing" approach in eastern DRC generally have a less infrastructure-intensive focus than the World Bank project discussed above. Because of recent conflict and continuing instability, many recent projects in this area involve vulnerable populations and emphasize food security. In a region where private-sector suppliers have often been the sole form of support to farmers, those projects focus interventions on provision of technical assistance and inputs necessary for farmers to sustainably increase yields of their crops. For example, the International Fund for Agricultural Development (IFAD) approved the $39 million project supporting the Integrated Agricultural Rehabilitation Program in Maniema Province (PIRAM) in 2008. The project targets rehabilitation of infrastructure and feeder roads, revival of agriculture and fishing, and improvement of access to safe water and health care. The implementation zone covers the less densely forested southern territories of the province. IFAD assessed the program as "not likely to have any significant negative environmental impact," and neither the program document nor the mid-term review (IFAD, 2014) references potential or actual impacts on the region's forests.[26] Available documents suggest that the project design does not include measures to increase profitability of forests for local communities.

The more recent 5-year $20 million USAID Resources to Improve Food Security in Eastern Democratic Republic of the Congo (RISE) project began in 2011 and works with community groups in North Kivu to sustainably increase agricultural production and improve nutrition and health practices among vulnerable groups. The agricultural component of this project promotes improved techniques and practices, and targets eradication of crop disease. Quarterly reports highlight multiplication and dissemination of improved varieties, including varieties resistant to cassava mosaic disease. The project also works to improve storage and marketing and agro-business development. Project documents reviewed do not include discussions of potential impacts on forest and actions taken to mitigate them.

Like RISE, the $50 million USAID Jenga Jamaa 2 5-year Food for Peace project (2011-2016) targets food security and vulnerable populations in a post-conflict context. Working in Southern Kivu province, the project targets agriculture and marketing, health and nutrition, and women's empowerment and resilience. Like RISE, Jenga Jamaa 2 emphasizes multiplication and distribution of improved varieties in its agricultural component. Project Farmer Field Schools promote agroforestry and soil management techniques, and while the Mid-Term Assessment reports that farmers have become aware of these techniques, it does not convey rates of adoption. It also highlights persistence of swidden agriculture and prevalence of overharvesting of forest products in the project zone (ADRA, 2014).

Although the zone is distinguished by densely populated smallholder agriculture in close proximity to forest, fundamental food security, health, and basic production concerns have justifiably dominated the objectives of donor investments in the post-conflict context of eastern DRC. An approach based strictly on intensification —whether through direct assistance to farmers or in cooperation with input providers—would be viable if farmers receive prices high enough to cover the costs of intensification. Cross-border demand from Rwanda and Uganda does support higher prices than elsewhere in the country (O'Donnell et al., 2015). Greater earnings may then enable farmers to overcome capital constraints to purchasing mineral fertilizers and labor constraints to performing the integrated soil management practices necessary to maintain soil fertility (Lambrecht et al., 2014). Adoption of recommended and promoted disease-resistant varieties is also a form of intensification that may dramatically increase yields (compared to yields of crops destroyed by disease) with no increase in demand on soil nutrients. In this densely populated region with high agricultural potential and strong cross-border markets, sustainable intensification of staple crop production within the existing rural complex could both reduce out-migration to forested areas and lengthen local fallows.

To determine whether these expectations come to fruition, these agricultural projects must more incisively monitor and evaluate project outcomes, and communicate available information regarding those outcomes.

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[26] Another IFAD project, the $53m North Kivu Agriculture Sector Support Project, aims to improve food security and increase smallholder farmer incomes by strengthening the maize, rice, potato, and Arabica coffee value chains. Signed in December 2015, no further information is available on the project.

Pending definitive assessment of project results, incomplete agricultural intensification and farmers' search for fertile soils will continue to increase pressure to clear new lands.

Illustrative projects designed to introduce or intensify agriculture on savanna

The GDRC's PNIA includes as an important objective: promotion of intensive private/public collaboration in large-scale, export-oriented agricultural projects with a special economic status on the country's savanna near urban centers (*Ministère de L'Agriculture et du Développement Rural,* 2013). The government's first concrete step in this direction is the Bukanga-Lonzo Park. Here, the government is creating an 80,000-ha, "self-sustained economic unit" with a large-scale capital intensive farm and separate, titled land for small-scale producers. The first component is a fully mechanized export-oriented pivot irrigation system that so far has produced two seasons of maize. The agricultural advisor to the Prime Minister reports that the second component currently supports 470 households, with allocations of a quarter ha per person. These households will benefit from roads, schools, clinics, technical advice, access to inputs, and market to be provided by the large-scale commercial component. If the government goes on to create the 20 similar agro-business parks as planned, and these are all the size of Bukanga-Lonzo Park, 1.6 million ha of new or degraded land will undergo annual crop cultivation.

Bukana-Lonzo Park takes an approach unlikely to increase pressures on DRC's forested lands. This "land sparing" project has no explicit REDD+ component, yet DRC's REDD+ strategic plan proposes rapid implementation of 20 such large-scale agricultural projects away from the country's forests, on the underexploited savannas. The capital-intensive agricultural system is unlikely to be adopted for forest areas, especially because it depends on irrigation. In fact, one explicit objective of the Bukana-Lonzo Park, in addition to economic and food security, is to engage large numbers of people in agricultural and non-agricultural jobs, and thus draw migrants to the zone and retain potential migrants who would otherwise move to forested areas. Together, the 20 parks target creation of 1 million jobs.

The World Bank Western Growth Poles Project resembles the Bukanga-Lonzo Park, in part because both grow out of a World Bank effort to create a Special Economic Zone near Kinshasa (Kobina and Akua, 2015). In 2013, the World Bank approved $114 million for this project, which focuses on agricultural value chains (cassava, rice, and palm oil) in Bas Congo, Kinshasa, and Bandundu. Like the Bukanga-Lonzo Park, the project takes an infrastructure-intensive approach to achieve its objectives of reducing poverty and promoting economic growth. To support increased agricultural productivity, the project will construct rural transportation and market infrastructure, upgrade the electricity network, and, in part through special zone status, improve the climate for business and industry. Much of the project area consists of heavily farmed savanna, with pockets of gallery forest along waterways. The social and economic assessment prior to the project identified threats to natural ecosystems from road improvements and from agricultural intensification. It and the Project Appraisal Document conclude that the greatest threat comes from potential for conversion of natural environments in low-lying lands to areas of market gardening. To mitigate impacts on natural lands and forest, the social and economic assessment proposes that the project promote ecological intensification, restoration of degraded soils, reforestation, monitoring of agricultural conversion of lands, and environmental outreach and education for farmers (Faye, 2012). The Project Appraisal Document also notes that the project will not support new palm oil plantations that could encourage deforestation, but will finance only rehabilitation of existing over-aged village plantations.

Both the Bukanga-Lonzo Park and World Bank Western Growth Poles projects incorporate strategies to minimize impacts on DRC's primary forest, the most important of which is to locate these projects on non-forested and degraded lands near the capital where infrastructure can be provided and markets are accessible. However, possibly in the end, minimizing impacts of these two projects on the country's forests will come more from their implementation than from their design. While very slow progress is the norm for large-scale commercial projects in developing countries (Deininger and Byerlee, 2011), success here depends on private-sector investment and capacity for efficient management by the government, yet to be demonstrated. Impacts of these two projects and effectiveness of these mitigating measures may not be known for a long time, as the

institutional capacity elements have significantly slowed progress (Kobina and Akua, 2015). Like the Bukanga-Lonzo Park, the Western Growth Poles project remains in start-up stages, and initial contracts are not yet established (Implementation Status Report number ISR20277, dated 2015/08/05). While recognizing that the Bukanga-Lonzo Park is a pilot activity with a steep "learning curve" (for example, technical aspects of the minimum tillage system being applied have not been worked out), the government nevertheless harbors great aspirations for its success. Two new agro-industrial parks are scheduled to open in 2016. Bukanga-Lonzo Park, according to the project's website, was "the first step to a great agricultural reform…of the thought processes in Central Africa towards the development of agriculture." Whether this reform works or not, as noted above in our review of the REDD+ strategy, investment of scarce resources in this centralized, capital-intensive type activity will limit the government's will to increase agricultural growth through facilitation of less high stakes, more broad-based, smallholder development of the country's savanna. The following section describes ongoing agroforestry initiatives for charcoal production—an alternative, less capital-intensive approach.

Illustrative projects promoting intensification through tree crop cultivation

In contrast to the "land sparing" projects, a number of projects in the DRC have taken a "land sharing" approach to mitigate impacts on forests. From October 2006 until 2011, the World Agroforestry Center (ICRAF) worked with the CARPE project IP AWF in the Maringa-Lopori-Wamba landscape to promote introduction of trees into staple crop fields. ICRAF built the capacity of local community members to propagate and cultivate a large variety of trees and plant them in fields and home gardens. The project supported creation of local nurseries that produced valued local and exotic species to be used for a variety of purposes, such as to generate firewood, provide fruit and spices, and host bees and caterpillars. Because they maintain soil fertility, field trees were promoted to slow the rate at which farmers clear new forests. During its time with the project, ICRAF supported production and distribution of tens of thousands of trees. However, since discontinuation of ICRAF's work, no evaluation of the longer term success of these activities has occurred, and AWF does not continue to support the activities it and ICRAF initiated. The activity nevertheless raises the question of what would constitute success. ICRAF successfully developed techniques for nursery production of seedlings of a highly prized tree species that hosts edible caterpillars in the local forest, and successfully out-planted these seedlings on smallholders' lands. The assessment team visited a site that hosted an orchard, not field trees. The owner hoped to expand the orchard, which would likely occur at the expense of forested land. Domestication of valued forest trees, in effect, reduces the value of the forest to local communities.

Numerous private and private/public projects that take a "land sharing" approach to promote coffee and cocoa cultivation apply additional incentive mechanisms to limit impacts of these crops on forests.[27] The ProLand SI Working Paper concludes that in certain contexts, private-sector incentives can effectively promote more forest-friendly methods of cultivation of a variety of tree crops. Incentives systems, such as payment-for-ecosystem services and certification schemes, come in many forms. Companies can offer premium product pricing; facilitate access to inputs, technical training, and markets; create increased efficiencies; increase crop yields; and assure long-term resource sustainability. Incentives can also be designed to target increased income, ecosystem-friendly practices, or a mix of the two. Some schemes deny certification to farms created on deforested land. In the DRC context, where government support to agriculture is very limited, private-sector assurance of services is critical, as intensive support at the local level will be required for cocoa and coffee cultivation to expand in an intensive and shade-grown manner necessary to limit forest loss.

Numerous projects using certification schemes in promotion of cocoa cultivation operate in North Kivu. This recent growth does not occur on abandoned or under producing plantations. Cocoa was not introduced in this province until 1998, and the majority of fields have been planted within the last decade. To a great

27 Although palm oil cultivation plays an important role in DRC's national plans for agricultural investment, few donor projects have been developed to support either this crop or rubber cultivation.

extent, they are being developed/created in a sustainable and land sharing way. A survey in 2013 by a CCAFS team found that 80 percent of farms are organically certified and grow cocoa in agroforestry systems that contain 50-80 shade trees per ha (De Beule, Jassogne, and van Asten, 2014). In the North Kivu areas around Beni and Butembo, the company ESCO Kivu SPRL (which initially received funding from *Deutsche Gesellschaft für Internationale Zusammenarbeit* [GIZ]) provides farmers training, support, and certification. The company gives farmers high-quality tree stock, and trains them to grow shade trees, recycle nutrients, and manage pastures and fruit trees (GIZ, 2009). As of 2014, the company was working with about 16,000 farmers on farms of about 1 ha each. ESCO usually pays a 15-percent premium over the wholesale market price of cacao to incentivize farmers to produce and ferment cacao during conflict, support crop loss due to violence, and ensure produce quality and loyalty to ESCO. The company exports specialty organic chocolate to processors such as Theo's in Seattle (Kibriya et al., 2014). In 2016, the Fair for Life Social & Fair Trade Certification Program re-certified ESCO Kivu with high marks for both fair trade and environmental performance.

Within the CARPE Ituri-Epulu-Aru Landscape, WCS has also engaged in a partnership with ESCO Kivu to provide incentives for maintenance of trees as habitat for wildlife on cocoa farms. Nine cocoa cultivation corporations were formed and provided with nursery materials, and their members were trained in seedling production. The trees are planted in degraded forest areas. A preliminary analysis of impacts of this cocoa cultivation on deforestation found that households cultivating cocoa reduced their farm size for food crops by 40 percent. Because the majority of the old plantation areas are now functionally inaccessible, growth in the cocoa sector will likely occur on fallow lands in regions less constrained by tenure conflict. While the CCAFS study concludes that cocoa cultivation in North Kivu expands at the expense of forest cover, for the most part, these will be fallow lands or secondary forest. WCS argues, reasonably, that cocoa promotion may also help settle migrants otherwise destined to clear forest for agriculture, thereby shifting investment away from fallow systems.

As eastern DRC recovers from conflict, a number of private/public partnerships have also been established to support coffee production. As with cocoa cultivation, great potential exists for increasing coffee yields, strengthening producer organizations, improving local processing, and providing better access to markets. To date, more than 26 co-ops and organizations work in coffee cultivation in the DRC (Caspersen, 2016). Most of the projects seek or have gained certification, commonly Fairtrade, which includes a mix of economic, social, and environmental criteria and objectives. In one of the larger projects, the Belgian NGO Vredeseilanden supports cooperative development and micro-washing stations, and facilitates market contacts. The project has distributed 3 million improved seedlings and promoted good agricultural practices, including agroforestry with shade trees. The private/public Kahawa Bora Ya Kivu project funded by USAID and the Howard G. Buffet Foundation, and implemented by Catholic Relief Services, the Eastern Congo Initiative, and World Coffee Research, targets enhancing local livelihoods through good agricultural practices, local processing, strengthened cooperatives, and improved marketing. Other projects include the Ituri Coffee Project implemented by SHIFT Social Impact Solutions; Project Congo, implemented by On the Ground, which emphasizes women's empowerment; and the Congo Coffee Project, founded by Equal Exchange with the Panzi Foundation. The British trading company Twin is supporting *Solidarité Paysanne la Promotion de Actions Café et Développent Intégral* (SOPACDI), which in 2011 was the first DRC cooperative to be Fairtrade-certified (Alternative Grounds, n.d.).

For coffee cultivation, research on effectiveness of certification schemes that provide incentives for reducing deforestation has demonstrated a number of successful cases elsewhere in the world (ProLand SI Working Paper). However, despite the great publicity regarding these ongoing programs, this assessment has identified no studies that provide field-based evidence of effectiveness of coffee certification in eastern Congo, which limits coffee's expansion to abandoned, fallow, or secondary forest. Nor was an assessment found of efforts of the CRS project in collaboration with WCS that supported coffee planting on the periphery of the Kahuzi-Biega national park as a buffer to expansion of staple crop farms into the park in the area of the park's gorillas. For both cocoa and coffee cultivation, further studies over a broader set of dimensions (gender, reinvestment of profits, labor flows, fertility) conducted over the course of many years would be necessary to

evaluate eventual impacts on forests nearby this public/private investment in tree crops. Maintaining effective incentive schemes is not a simple task. Adoption and maintenance of performance standard schemes, and particularly meeting current cash and labor costs, can be challenging for small producers. Certification schemes that do not guarantee a premium to producers for adopting the specified practices may impose greater burdens on farmers. In the long run, standards must be integrated into government policies and regulations, in collaboration with the private sector, to increase potential for effective, long-term sustainability. Despite the seeming rush of activity in eastern DRC, the International Coffee Organization reports that potential insecurity and high levels of corruption still render financial institutions reluctant to invest in coffee cultivation in the DRC (International Coffee Organization Blog). As the overall context for production and marketing cocoa in the DRC recovers, improved management of the country's forests will also be necessary to prevent wholesale conversion, as has occurred in West Africa.

5.2.2 ONGOING CBNRM INITIATIVES

CBNRM for the humid forest. The number of CBNRM pilot initiatives in the DRC has recently been expanding substantially, and now includes three very different examples. GIZ has a community-based natural forest management initiative in Maniema Province, where empowered communities are managing humid natural forests. A community cooperative is managing one community forest concession for saw timber. It is processing saw logs in the forest by use of a portable saw mill, and marketing the lumber produced. This has been developed as a response to the anarchic harvest of saw logs by artisanal chainsaw millers. Another community is developing multi-purpose forest management on its concession, and a third concession is still in the planning stage. The legal instrument used to empower community managers was a decree (arrêté) issued by the provincial governor. The final national-level *arrêté* issued on February 9 of this year specifically excludes use of portable sawmills by community managers for processing saw logs, which will considerably weaken efficiency and quality of local milling, and may weaken the GIZ project. Portable sawmills produce lumber to very precise dimensions, and their thin-kerf band saws are much more efficient in processing saw logs than manually operated chainsaws with much wider kerfs. Reportedly, WWF is interested in adapting the model to Mai Ndombe Province (Munduku, n.d., Interview).

A community-based wildlife management system for sustainable production and marketing of bushmeat became operational in December 2015. It was developed by the FAO Global Environment Facility (GEF) Bush Meat Project, and it covers 81,000 ha managed by the three empowered communities of Bafwamogo, Bapondi, and Barumbi Tshopo. This community-managed area is located on the road between Kisangani and the Okapi Faunal Reserve. The first community targeted had to be dropped because of a land tenure conflict. The project restarted from scratch with the three new communities in May 2015, and the new management system was operational by December 2015. Again, the legal instrument was negotiated at the provincial level.

One of the key challenges of community-based wildlife management in the humid forest region is identification and use of a practical method of monitoring wildlife abundance so that community managers can adjust their level of harvest as a function of wildlife populations. The technique identified in the Bush Meat Project design (FAO, 2010), and now undergoing test on site, was developed by *Centre de Coopération Internationale en Recherche Agronomique pour le Développement* (CIRAD) researcher Christian Fargeot in Central African Republic (Fargeot, n.d.). Community managers must maintain two registers: 1) a registry of all game harvested by species and by kg, and 2) a registry of man-days spent by hunters. Together these two registries combine to form a rough measure of wildlife populations, by species. Sustainable offtake from relatively high wildlife populations is considerably higher than that from depleted populations, so communities have a built-in incentive to maintain high game populations. Through trial and error use of the abundance index, they should be able to determine optimal population levels that will yield greatest returns. This should serve as an incentive to maintain high population levels.

An incident occurred during this project that indicates replication and scaling up of community-based wildlife management could proceed quite efficiently without major inputs. For 3 years, FAO IPs CIRAD, CIFOR, and the International Union for the Conservation of Nature (IUCN) worked with communities at another site nearby. But when it came time for the government to empower them, they learned that the communities

they had worked with did not hold the rights to the land, according to the traditional tenure system, and the traditional land owners were firmly opposed to empowerment of those to whom they had lent hunting rights. Beginning in May 2015, the lead national consultant for FAO began applying the same basic methods working with new communities at a new site—including socio-economic analysis, multi-resource inventories, creation of local institutions representing communities and stakeholders, delimitation of communities' hunting lands, and development of a simplified management plan. The community-based wildlife management systems described here were operational by December 2015. The local government sector chief has authorized the community management structures to become operational while the formal application for a community forest concession is pending with the national Ministry of the Environment and Sustainable Development.

The approved community regulations governing access and hunting are numerous and can generally be grouped under the following headings: 1) approved hunting techniques, limitations on types and numbers of hunting implements, and their registry; 2) conditions of access by outsiders and payments they must make for hunting rights; 3) limitations on the number of hunters by month and by year; and 4) possibility of imposing future quotas.

In addition to the community management institutional structures, four stakeholder platforms were created: 1) public institutions (national and international NGOs and a research institution); 2) elected officials, traditional chiefs, and notables; 3) journalists and friends of the environment; and 4) women bushmeat merchants. Reportedly, these stakeholder platforms have been very important in rapid and successful completion of the process.

Community-Based Miombo Forest Management. A third CBNRM project, also developed by FAO, just received final approval by GEF in March 2016, and is scheduled for start-up in June. It was developed in strong conformity to the principles of successful CBNRM presented in Table 2 of this report. This new project will develop community-based management of miombo forests in the Lubumbashi charcoal supply zone. Design of the project draws heavily from lessons learned during the 30 years of CBNRM experience in the dryland forests of Sahelian West Africa. It will support participatory zoning of community lands into agricultural and community forest land use categories. It will work with communities to develop sustainable management systems for three categories of lands: 1) intact miombo forests, 2) low-productivity secondary miombo forests that have been cropped and/or nearly clear cut for charcoal, and 3) severely degraded lands within a 35-km radius of Lubumbashi's zone for forest management. A previous FAO project in this third zone at Kikonké demonstrated how easy it is to regenerate miombo, even on severely degraded lands, through simple protection. All forest will be managed for the full range of wood and NTFP that the forest is capable of producing (FAO, 2015).

For the agricultural lands, the project will support adoption of improved swidden systems with long-term (10-year) miombo fallows. This is an agroforestry system similar to those developed with the plantation of exotic species at Mampu and Ibi Village (see the next paragraphs), but will occur at much lower cost because it will rely on natural regeneration. These miombo fallow systems will enhance both crop yields through soil fertility maintenance and improved production of charcoal and other wood and non-wood products from fallow lands. Adoption of such systems, however, would require redistribution of cropland among households, and will occur only where communities assent to this. A key to success of both the miombo fallow agroforestry system and the community-based miombo forest management will be restoration and adaptation of traditional fire management systems. Miombo regeneration following charcoal cutting and following cropping is severely reduced at present because of the anarchic, uncontrolled burning practices that have developed in recent times (FAO, 2016).

Donor-funded agroforestry initiatives for charcoal production

Two agroforestry initiatives established on grasslands within the Kinshasa charcoal supply zone have involved planting of nitrogen-fixing Australian acacias for medium-long fallow agroforestry systems that produce both

charcoal and basic food crops. Both claim to maintain soil fertility. The Mampu Project on the Ibi Bateke Plateau began in 1979 and was based on an industrial forestry model. Between 1987 and 1993, the project planted thousands of ha of Australian Acacia on the degraded savannah grasslands 140 km from Kinshasa. Between 1995 and 2006, 300 plots of 25 ha each were "leased" free of charge to 300 households. Beneficiary families, who come primarily from urban centers areas (largely Kinshasa), engaged share croppers and paid laborers to work the farms. The fields were to be managed as long-term swidden system, with 10-year fallows, and 2 years planted in corn and cassava. Field owners produce an estimated 10,000 tons of charcoal from the acacia yearly. This constitutes 1.6 percent of Kinshasa's demand (Peltier et al., 2010).

Over time, use of the land has deviated from the original Mampu Project plans. Ducenne (2009) found the scheme had grown to 1000 families (3000 people), each making an average of 1000 Euros per family. The acacia's nitrogen-fixing properties enhanced crop yields, especially after the first clearing. Acacia was regenerated by burning after cropping to begin the second fallow cycle, to stimulate germination of the Acacia seed. This time, the seedlings grew slower and were frequently outcompeted by native species of lower quality for charcoal. In part as a result of this decrease in the wood's value for charcoal, some farmers are not respecting the 12-year cycle and are cropping again after a five-year fallow. This is insufficient to properly restore soil fertility. The approach is also limited by perceptions of some farmers that Acacia stumps are a nuisance that prevents plowing. Those farmers with money to invest prefer to buy land and rent tractors to plow. Ducenne (2009) concluded that the initiative is highly profitable and could be made more so by implementing efficient charcoaling techniques, using improved acacia varieties, increasing cassava yield, and applying the model to large industrial plantations. The project reportedly sequestered 113,000 tons of carbon per year in the first cycle, avoided destruction of 500 ha of gallery forests, and provided an economic output equivalent to 30,000 ha of shifting cultivation fields (Ducenne 2009). The authors propose use of charcoal taxes to support new plantations, and of REDD+ credits to protect gallery forests.

The Forest Carbon, Markets and Communities (FCMC) Global study team found the Mampu system to be the most promising approach for REDD that they encountered in DRC. They think it could be used to attract migrants from forest areas to the savannas, and to decrease out-migration from the savanna to forest areas. They argue that it should not be converted into an industrial approach because of the negative impacts on households.

Another scheme, run by a Congolese private company called Novacel, intercrops cassava with Acacia mangium and *A. auriculiformis* trees 170 km from Kinshasa at the Ibi Village site in order to generate food and sustainable charcoal, as well as carbon credits. To date, about 2,500 ha has been planted, and the oldest plantations have reached harvest size. These plantations are also managed in an agroforestry system with a 7-year wooded fallow and a 2-year cropping period for cassava. The trees have to be replanted from nursery stock after each cropping cycle. The company has also received some initial carbon payments. Novacel reinvests part of its revenue from carbon credits into local social services, including maintenance of an elementary school and health clinic.

Mampu and Ibi Village have demonstrated that one can produce a lot of charcoal from the grasslands around Kinshasa, but no private-sector company has invested in such plantations without substantial subsidies. The World Bank and African Development Bank-funded Forest Investment Plan report that new plantation establishment costs are about $700 to $1400/ha, and that they will subsidize 50 percent of the costs to private-sector companies. Land tenure is a major constraint, and they will fund only those who have a title deed to the land to be reforested.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

USAID tasked ProLand to undertake this assessment to answer the following questions:

- Where are forest and carbon stocks being lost most rapidly in the DRC?
- What are the overall drivers of this loss, and which are associated with agriculture?
- What are the impacts of different agricultural systems on forests and carbon stocks?
- Taking the country as a whole, what opportunities are there for USAID to promote agriculture in the DRC while minimizing impacts on forests?
- What approaches and practices can be scaled up?

KEY FINDINGS

Deforestation and its causes. Regarding distribution, rates, causes, and drivers of carbon and forest loss, available information enables only an incomplete response. We know that between 2000 and 2014, canopy cover on 8 million ha within the DRC dropped below 30 percent, the highest rate of rainforest loss among Central African countries (Global Forest Watch, n.d.). Yet, while such accurate longitudinal data exists regarding tree cover loss, country-level information of similar accuracy does not exist regarding net changes in tree cover, forest degradation, or forest carbon emissions. The dynamics of forest loss also remain poorly understood. Despite these knowledge gaps, the assessment draws a number of broad conclusions concerning forest loss in the DRC:

- Smallholder farmers, virtually all of whom practice swidden agriculture, are the major cause of deforestation. From 2000 to 2010, lands occupied by smallholder farmers practicing swidden agriculture increased by 46,182 ha, increasing from 12 to 13 percent of the country's total land area (Molinario, Hansen, and Potapov, 2015). Distribution and rate of swidden expansion are influenced largely by subsistence demands associated with demographic factors, including both natural population growth and migration.
- Smallholder swidden agriculture has expanded most rapidly in fronts along population-dense rural zones, out from urban centers, and along transportation routes. By changing access to markets, improvements to the country's road network may pose the greatest single risk to forests in the near term.
- The other principal causes of deforestation are overcutting for wood fuels for urban markets and unsustainable timber harvesting. The formal industrial logging sector has shrunk considerably in recent years, and now harvests only one-thirteenth of the amount harvested by small-scale, almost totally unregulated, artisanal chainsaw millers. A major (yet unquantified) problem is fraudulent issue of ACPs to companies of industrial capacity for uncontrolled harvest and export of saw timber.
- While large-scale commercial agriculture is an important potential cause of deforestation in the DRC, at present its expansion is inhibited by: 1) the requirement that only Congolese-majority-owned companies can receive concessions, 2) a business climate characterized by widespread government corruption and a legal system unable to enforce contracts, and 3) formidable land tenure constraints.

The development context. The national development context imposes significant constraints on large-scale implementation of changes in agricultural and forest management systems described in this assessment. The country is recovering from conflict, and reestablishing and reforming its government; the government controls limited resources and remains vulnerable to corruption. Large-scale implementation of support for sustainable agricultural intensification and forest management will intersect with other national-level conditions that may reinforce or constrain positive change. Relevant constraints, discussed at greater length below, include outdated and poorly implemented policy and legislation regarding land and natural resources management, limited public- and private-sector investment in agriculture, an inhospitable business climate, and absence of public services and infrastructure across much of the country.

Challenges facing agricultural intensification with limited impact on forests. To meet its food security and economic needs, the DRC must dramatically increase agricultural output. Potential for this is real, as the country contains over 20 million additional ha of non-forested land suitable for agriculture, and yields of the most common farming system at present are well below what has been demonstrated possible elsewhere. However, achieving this potential will require a radical transformation of current practice. Challenges differ by agricultural system. A limited number of areas in the country have population density and market systems critical to intensification of swidden agriculture. In areas where swidden farmers do adopt yield-raising inputs, they often do so at the expense of soil fertility, an indirect driver of deforestation. Tenure constraints limit regeneration of degraded plantations, while effective systems have not been implemented to manage expanded cultivation of cocoa and coffee—crops with potential for intensive, environmentally friendly, sustainable growth. The government's program for enabling agriculture on underused non-forested land targets capital-intensive agricultural systems, not small holdings.

Institutions and incentives that deter deforestation from agricultural intensification. Outside of protected areas, virtually no institutions limit the greatest drivers of forest loss in the DRC. Integrating land into swidden systems by clearing forest currently generates value for smallholder farmers. The vast size of the country, its inefficient transportation system, and the government's limitations require community engagement in creating institutions necessary to change incentives. The DRC must transfer management of much of its forests to systems that benefit local communities. In the long run, this approach will require a socio-economic sea-change that empowers local communities and increases their management rights via distinct strategies applicable to PAs, industrial forest concessions, non-gazetted forest lands, and future community forest concessions. For this approach to succeed, communities must derive substantial benefits through sustainable management of forests, and range of their products, including wood fuels, saw timber, wildlife, and NTFP. To accomplish this, communities and forest-based enterprises will require training and capacity building. Policies, regulations, and institutions will have to be adapted, and value chains strengthened and rendered more competitive.

Greatest opportunity to intensify agriculture and sequester carbon. The humid forests and savannas of the charcoal supply zones around urban centers present the greatest opportunities for intensive community forest management and intensification of smallholder agriculture.

STATUS OF CARPE FIELD ACTIVITIES

- CARPE implementation partners have modestly invested in agriculture within the project landscapes, and effectiveness and widespread adoption of integrated soil fertility management practices are not fully evident.
- CARPE implementation partners have not developed monitoring and evaluation systems to track impacts of their agriculture activities on forests. (Given the small size of current investments, absence of these systems may be justified.)
- CARPE implementation partners have not yet demonstrated how their activities create incentives to reduce forest loss; no operational systems to incentivize communities to protect forests have been developed.

RECOMMENDATIONS FOR USAID AND THE DONOR COMMUNITY

To mitigate impacts on forests, projects designed to sustainably intensify agriculture in the DRC will require careful attention to where investments are directed and how investments are designed. Based on the report findings, agriculture investments may also require specific complementary actions to conserve nearby forest. The assessment offers the following recommendations for creating a more balanced and integrated approach to increase agricultural productivity and reduce forest loss:

Take a landscape perspective in locating activities. Any agricultural activities should occur at a distance from unprotected forests. The appropriate distance will depend on the agricultural system and its potential to spread. In the long term, no distance may be "safe" without effective management of the country's forests. Agricultural investments may be located near forests only when effective means to protect against forest loss are in place.

For the greatest impact, intensify production from agriculture and forests in areas with the strongest market demand. Urban demand supports prices necessary to drive smallholder agricultural intensification, as well as access to inputs necessary to implement this. Community forest management activities will be most successful where demands and prices for forest products (charcoal, timber, NTFP, and bushmeat) are greatest. Urban demand for wood fuels in particular creates conditions for development of community-based, multiple-use, intensive natural forest management systems and agroforestry. IPs should target areas where forest-based CBNRM can be clearly profitable for communities, where population pressure is greatest, and where primary forests and PAs are at greatest risk. Potential target areas include southern Ituri, eastern Kahuzi-Biega, northern Virunga landscapes, and the interior of Lac Tele-Lac Tumba, wherever significant forests remain outside of PAs.

Monitor impacts of agriculture on forests. If CARPE IPs intend to manage the relationship between agriculture and forests, they must monitor this. CARPE, with the larger development community, should establish baselines and monitor effects of agricultural investments on factors critical to forest change, such as soil fertility, migration patterns, and provision of forest products through agroforestry. At the project level, this would ideally be integrated into existing monitoring systems that track environmental and economic impacts.

Increase understanding of landscape dynamics. Researchers in DRC need to focus more directly on the relationship between agricultural growth and forest loss. To address agriculture's impact on forest loss, donors and government must support applied research focusing on knowledge gaps in that regard in order to inform and guide government investments and donor program design and project implementation. Gaps identified in this assessment include identification of hotspots of carbon emissions; agricultural suitability and potential, particularly of non-forested lands; direct causes (agricultural and otherwise) of deforestation and forest degradation; and geography and dynamics of charcoal value chains.

Plan and manage for the long term. The DRC will not resolve the barriers to intensive agricultural growth and sustainable forest management before the conclusion of CARPE III. Activities proposed by this assessment will likely require investments over the next two decades. Over that time period, USAID will necessarily change strategies, funding streams and mechanisms, and IPs. Achieving biodiversity, forest carbon, and agriculture objectives will require different approaches and activities. Long-term goals must be met through flexible management mechanisms. Using adaptive learning, USAID and CARPE IPs will have to capture and implement lessons learned, and maintain continuity in addressing stated priorities, as project objectives, funding sources, and the development context change.

Collaborate to address fundamental constraints. The donor community must collaborate with civil society, the private sector, and the government to address the broader conditions that constrain sustainable agricultural intensification and forest management. As the economy improves, population grows, transportation infrastructure expands, and business investment returns, the "passive protection" now

provided forests will diminish, and pressures on forests will mount dramatically. Specific issues that should be addressed include decentralization of natural resource management and devolution of forest management rights and authority, effective operationalization of national land use planning, facilitation of forest-based enterprise development, reform of concession management, and allocations of ACPs. Moving forward on these issues will require policy dialogue, as well as development and refining of approaches at the local level.

RECOMMENDATIONS REGARDING CARPE

Reconsider investment in agriculture. To date, CARPE partners have not invested heavily in agriculture. Given the challenges to sustainable intensification of swidden systems, and the difficulty of limiting impacts of agricultural investments on forests, CARPE management and IPs should consider revisions to their approach. Opportunities for agricultural investment identified in this assessment do not apply to all portions of all landscapes. At the same time, piloting and refining community forest management approaches made easier by the new law supporting community forest concessions will demand project resources. We recommend that CARPE support agriculture only where community forests have already been put under sustainable community forest and natural resource management, and scale up only approaches demonstrated to maintain soil fertility over time.

Build teams that have the expertise and motivation to undertake CBNRM, and, where relevant, agriculture. Development of commercially oriented CBNRM systems that generate revenues and new benefits will require mobilization of people with significant experience and expertise in these areas. Required expertise in skill sets includes: 1) development of strong capacities for good governance, transparency, safeguards, and self-enforcement; 2) technical aspects of agriculture and natural resource management planning and implementation; 3) financial and economic analysis, strengthening of value chains, processing and marketing, and targeted assistance for natural resource-based enterprise development; and 4) self-financing and participatory monitoring of community management systems.

Take advantage of the new community forestry law. CARPE partners should aggressively take advantage of the new law. They should begin piloting approaches to sustainable community management of forests in different ecological and socio-economic contexts. The process should target development of the most economically and environmentally sustainable models of CBNRM in different community forest settings, and co-management in different logging concessions and protected areas.

ANNEX A: REFERENCES

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ANNEX B: LIST OF PEOPLE INTERVIEWED FOR THE ASSESSMENT

Date	Name	Organization	Title
1/12/2016	Matt Steil	WRI	Manager, Central Africa Forests
1/12/2016	Nancy Harris	WRI	GFW Research Manager
1/12/2016	Liz Goldman	WRI	GIS Analyst
1/13/2016	Tom Maschler	WRI	GIS Remote Sensing Associate
1/13/2016	Alexandra (Sasha) Tyukavina	UMD	Post-Doctoral Research Associate
1/13/2016	Juan Seve		Independent Consultant
1/14/2016	Noel Gurwick	USAID/DC	Sustainable Landscapes and Climate Change Advisor
1/14/2016	Diane Russell	USAID/DC	Senior Social Scientist, Forestry and Biodiversity
1/14/2016	Lucy Gibbon	USAID/DC	Climate Change Advisor
1/19/2016	Michelle Weiland	WCS	Central Africa Livelihoods Coordinator at Wildlife Conservation Society
1/22/2016	Richard Paton	USFS	Central Africa and Middle East Regional Advisor
1/27/2016	Jason Ko	USFS	California Forest Legacy and Stewardship Program Manager (Detail)
2/5/2016	Nicodème Tchamou	USAID/West Africa	NRM and Climate Change advisor
2/8/2016	Antoine Eyebe	USAID/DRC	NRM Specialist
2/8/2016	Alastair McNeilage	USAID/DRC	Central Africa CARPE Team Leader
2/8/2016	Julie Fischer	USAID/DRC	Climate Change Advisor
2/8/2016	Patrick Smith	USAID/DRC	Deputy Director, Office of Economic Growth
2/8/2016	Augustin Kidima Ngeleka	USAID/DRC	Agriculture Advisor
2/9/2016	John Schluter	Café Africa DRC	Director
2/9/2016	Pascal Luzonzo Dopa	Café Africa DRC	Coordinnateur Pays
2/9/2016	Pascal Douard	WRI/Initiative Forets Afrique Central/GFW	Expert Technique geomatique
2/9/2016	Roger Mambeta NDONA	WRI/RDC Initiative Forestiere Afrique Central/GFW	Coordinnateur National, DRC
2/9/2016	Apollinaire Biloso Moyene	ICRAF	National Coordinator
2/9/2016	John Mafolo Kuwana	ICRAF	Agroforestry Specialist Supervisor
2/9/2016	Claude Mayimba	ICRAF	Junior Scientist

Date	Name	Organization	Title
2/10/2016	Frederique Jacquemont	CN REDD+	
2/10/2016	Raphael Kasongo Kabusa-Miburani	CN REDD+	M&E Expert
2/10/2016	Hassan Assani Ongala	REDD	Expert Chargé du Développement et de la Mise en Œuvre de l'ERPD
2/10/2016	Richard Tshombe	WCS	Director DRC Program
2/10/2016	John Mususa Ulimwengu	Primature	Agricultural Advisor
2/10/2016	Gloria MANGONI NDINDIR	Office of the Prime Minister	Research Analyst
2/11/2016	Jean Muneng	MEDD	Chef de Division Development Durable
2/11/2016	Benjamin Toirambé Bamoninga	MEDD	National Focal Point REDD+/DRC
2/11/2016	Dr Landing Mane	OSFAC	Director
2/12/2016	Hugues Akpona	African Wildlife Foundation	Congo Landscape Manager
2/12/2016	Brigitte Mbweli Bilonda	FAO	National consultant
2/1452016	Jean Paul Kibambe GIS WCS	WCS DRC Program	GIS Manager
2/17/2016	Mola Gabriel	FIB	FIB Representative
2/17/2016	Max Muland	IBI Village/Novacel	Manager Novacel
2/22/2016	Gabrielle Munduku	GIZ Foret	Head of Biodiversity and Forest program
2/22/2016	Omari	WCS	COP/CAFEC WCS
2/22/2016	Yannick Moluba Lukombo	WB DRC	Biodiversity Expert
2/23/2016	Lusakueno	Director of Production Vegetale et animale	Ministry of Agriculture
2/24/2016	Vangu Lutete	PIF Coordinator	Ministry of Environment
2/24/2016	Marc Rodriguez	PIF Technical Advisor	Ministry of Environment
2/24/2016	Monique Motty	Deputy Regional Coordinator	WRI DRC
2/24/2016	Jean Marie Bolika	Bienvenu Gata	WWF Project manager, Coalition platform against illegal logging (Bienvenu Gata), and the Autochthon peoples platform
2/24/2016	Gabriel Mola Motya	Federation des Industriels du Bois	President
2/24/2016	Elvis Tshibasu Muanza	WWF	Remote Sensing & GIS Expert
2/24/2016	Fabrice Inkonokoy	WWF	Assistant Conservation Director
2/24/2016	Yannick Moloba Lukombo	World Bank	Biodiversity Expert
2/25/2016	Leslie Ouarzazi	DRC	DRC UNDP/REDD

Date	Name	Organization	Title
		UNDP/REDD	
2/25/2016	Alain Huart	Sustainable Development Expert /Agriculture	CTP/DRC Rural Development Ministry project
2/25/2016	Raymond Batanga	COO	COO Feronia/ Lever plantation in Congo (DR)
2/26/2016 (USAID Debriefing)	Julie Fischer, Antoine Eyebe, Show, Augustin Kadima, Toussaint Molenge, Patrick Smith	CARPE Team	DRC USAID

ANNEX C: PROLAND TERMS OF REFERENCE

Productive Landscapes (ProLand)
Terms of Reference
USAID REPLACE IDIQ Task Order AID-OAA-I-13-00058/AID-OAA-TO-14-00050

Title: Assessment of opportunities to improve agricultural land use and reduce GHG emissions in the Democratic Republic of Congo (DRC)
Date: 10 December 2015
Component: Support to USAID/Kinshasa
Supervisor: Ben Caldwell, Tetra Tech Project Manager
Technical Lead: Bob Winterbottom, ProLand COP

Background

The ProLand (Productive Landscapes) project, awarded on September 30, 2014, is a 60 month task order under the Restoring the Environment through Prosperity, Livelihoods and Conserving Ecosystems (REPLACE) IDIQ. It is implemented by Tetra Tech in association with WRI and ACDI/VOCA. ProLand is managed by the office of Land Tenure and Resource Management (LTRM) in the bureau of Bureau of Economic Growth, Education and the Environment (E3).

The purpose of the ProLand project is to provide USAID assistance to catalyze change in land management systems so that people and institutions in developing countries can make informed, actionable, and effective development decisions. The goal of this Task Order is to develop tools and evidence to demonstrate that by sustainably intensifying land uses with best management practices, it is possible to achieve multiple gains simultaneously including increasing food production, reducing biodiversity loss, reducing greenhouse gas emissions (mitigating climate change), enhancing adaptation to climate variability and change, and increasing inclusive broad-based economic growth. The specific objectives are to demonstrate by the end of the contract that multiple benefits from sustainable intensification have been achieved using best management approaches that:

1. Increase agricultural production while also increasing carbon sequestration above and/or below ground on farming and grazing lands.
2. Increase biodiversity, for instance by reducing deforestation rates, increasing natural forests and rangelands, providing ecologically sustainable benefits to local communities, and enhancing ecosystem services.
3. Increase resilience of rural household livelihoods to climate change (i.e., increased variability of temperature and precipitation patterns), via increased rainwater capture/groundwater infiltration, diversification and integration of farm production systems, enhanced ecosystem service provision, and greater adoption of community-based natural resource management governance structures.

The specific tasks to be undertaken in support of these objectives include:

1. **Improving the evidence from existing successes** by documenting and disseminating existing data and success stories relevant to integrated climate change, biodiversity, food security, and natural resources management programs for increased landscape productivity and resilience.
2. **Developing a Nature, Wealth & Power toolbox** of methods and best practices for increasing landscape productivity and resilience;
3. **Preparing the future evidence base** for new success stories in productive landscapes management in programs under design in sites selected collaboratively with 1-3 key USAID Missions.
4. **Implementing a program of work t**o support the uptake of Community-Based Natural Resource Management (CBNRM) best practices.

Background for the Proposed Activities of ProLand in the DRC

In August, 2015, the ProLand team was requested to explore the needs of the USAID/Kinshasa Mission and CARPE partners in relation to the mandate of ProLand to catalyze change in land management systems and to demonstrate how synergies can be achieved from integrated approaches for sustainable intensification and improved natural resources management.

The ProLand team consulted with USAID staff in Washington DC, USAID/Kinshasa, and the Chiefs of Party of CARPE IPs (WWF, WCS and AWF) to discuss the possible scope of technical support that could be provided by ProLand. Following a review of the draft TOR by the ProLand COR, the following objectives, activities and deliverables for ProLand support in DRC were selected.

Proposed Objectives and Scope of the Assessment by ProLand

Proland will mobilize an interdisciplinary team to carry out a strategic assessment of the best ways to support sustainable agricultural intensification in DRC so as to reduce GHG emissions from land use change associated with the expansion of agricultural land use. The primary audience for the assessment is USAID and secondarily IPs.

Key questions for the ProLand team are:

1. What can USAID do and where should it be doing it to support sustainable agricultural intensification and sustainable land management?
2. Where is agricultural development (large-scale commercial and subsistence) threatening key habitats and how does the threat from agriculture interact with other drivers of deforestation and degradation?
3. Where is agriculture markedly reducing carbon stocks, and are there areas where interventions to enable sustainable agriculture intensification are a priority for both sustainable landscapes and biodiversity conservation?
4. What approaches and practices can be scaled up and within what time frame?
5. How can USAID-supported activities be made more sustainable?
6. What should be done in relation to agriculture-driven deforestation, and who should be doing it?

The team will:

- Focus on potential interventions that could have an impact at scale.
- Take account of what the key actors in DRC are doing to address deforestation and degradation, and to support sustainable agricultural intensification.
- Take account of concerns and factors affecting investments by the private sector.

Proposed Activities of the ProLand Assessment

Phase I December – January

1. Complete a desk/literature review in relation to the objectives and scope of the assessment, including publications and reports shared by USAID, as well as a review of available information on concessions and land use plans in DRC.
2. Collaborate with Matt Hansen's University of Maryland team (including Giuseppe Molinario), WRI's Global Forest Watch team, and the WRI-led CARPE team to use available imagery and analysis of spatial data to identify key drivers and landscapes with high rates of deforestation and degradation. It will convene a working session that examines available imagery and data to gather evidence that would help to identify what can be done and where to address large-scale deforestation (and degradation and burning) in relation to agricultural development
    - Identify major landscapes where deforestation and agricultural development intersect; and note where ongoing agricultural development interventions are located.
3. Analyze the relative importance of the major, direct, and indirect drivers (root causes) of deforestation and degradation.
4. Develop possible solutions for the most important threats and drivers, and assess the extent to which these solutions have been supported and the relative success of these possible solutions; identify promising innovations and "best practices," including interventions designed to overcome the major barriers to successful implementation at scale of the most promising solutions. Consider the need and opportunity for supporting integrated approaches that leverage the key principles of "Nature Wealth and Power" and experience gained to date in applying this framework.

Phase II January-February

5. Organize visits to key sites to ground truth spatial analysis and to learn more about the dynamics of agricultural development threatening forests and key habitats (whether or not these habitats and landscapes are located in current CARPE partner landscapes), and to explore the feasibility of possible solutions and their successful implementation.
    - During consultations in DRC, meet with major actors to discuss key changes in enabling conditions that could trigger widespread behavior changes and to support strategic interventions and investments designed to scale up the most promising solutions.
    - Identify opportunities for restoring degraded agricultural land and abandoned agribusiness plantations – in and around the Kahuzi Biega landscape and other priority/accessible areas.
    - Consider what might be the most effective entry point for interventions at the community level in targeted landscapes, taking account of opportunities to build social capital and constituencies with those engaged in agriculture in ways that would contribute to more sustainable intervention strategies (i.e. not based on continued provision of inputs from CARPE IPs).

Phase III February-March

6. Formulate the following recommendations in a report:
    - The most cost-effective interventions to address the key threats and drivers of deforestation and degradation, and to support promising solutions at scale for sustainable agricultural intensification and associated sustainable land management and improved natural resources management.
    - The most critical landscapes to be targeted by USAID investments aimed at sustainable agricultural intensification and to reduce GHG emissions from deforestation, degradation, and land use change.
    - The critical capabilities and expertise needed by USAID partners to provide support for successful implementation of the most promising solutions at scale.
7. Present results to USAID.

Deliverables

By the end of March 2016:

- A technical report summarizing research, analysis, and key findings, including results of meetings, consultations, and field visits
- A presentation of the principal recommendations of the ProLand team.

Team Composition

Core technical assistance would include the following specialists:

- CBNRM and agroforestry specialist with experience in fuelwood production and community-based forest management, and analysis of Nature-related issues (Roy Hagen)
- Sustainable agriculture and governance specialist with expertise in climate smart agriculture and analysis of Power-related issues (David Miller)
- Ecosystems services specialist with expertise in natural resource economics and analysis of Wealth-related issues (Doug White).

Management and targeted technical support to the team will be provided by Ben Caldwell, Project Manager, Bob Winterbottom, COP, and Mark Donahue, DCOP for Proland.

Additional staff from WRI's Global Forest Watch team will provide support in Phase I of the project.

Level of Effort

Estimated level of effort, including preparation, travel and fieldwork, and reporting are as follows:

- Project Manager – 1 week for project management
- ProLand COP – 2 weeks for orientation, and assistance with documentation and report preparation
- ProLand Deputy COP – 2 weeks for assistance with literature reviews and finalization of report
- CBNRM and agroforestry specialist – 10 weeks and up to 2 round trips
- Sustainable agriculture specialist – 5 weeks and 1 round trip
- Ecosystems services specialist – 5 weeks and 1 round trip.

Place of Work

The ProLand team will work from their offices in the USA and travel to DRC for fieldwork approved in the TOR.

ANNEX D: PROLAND SCOPE OF WORK FOR WRI

Productive Landscapes (ProLand)
Scope of Work
USAID REPLACE IDIQ Task Order AID-OAA-I-13-00058/AID-OAA-TO-14-00050

Title: Analysis of Geospatial Data to Inform the USAID ProLand Assessment of opportunities to improve agricultural land use and reduce GHG emissions in the Democratic Republic of Congo (DRC)
Date: Feb 11 2016
Component: Support to USAID/Kinshasa
Supervisor: Ben Caldwell, Tetra Tech Project Manager
WRI POC: Matthew Steil

Background

ProLand

The ProLand (Productive Landscapes) project, awarded on September 30, 2014, is a 60 month task order under the Restoring the Environment through Prosperity, Livelihoods and Conserving Ecosystems (REPLACE) IDIQ. It is implemented by Tetra Tech in association with WRI and ACDI/VOCA. ProLand is managed by the office of Land Tenure and Resource Management (LTRM) in the bureau of Bureau of Economic Growth, Education and the Environment (E3).

The purpose of the ProLand project is to provide USAID assistance to catalyze change in land management systems so that people and institutions in developing countries can make informed, actionable, and effective development decisions.

ProLand DRC Assessment

Proland has been asked by USAID to mobilize an interdisciplinary team to carry out a strategic assessment of the best ways to support sustainable agricultural intensification in the Democratic Republic of the Congo (DRC) so as to reduce GHG emissions from land use change associated with expansion of agricultural land use. The primary audience for the assessment is USAID and secondarily IPs.

Scope of Work

As the lead implementer of ProLand, Tetra Tech is requesting WRI and the University of Maryland to provide a number of mapping products and deliverables to address the following questions and tasks from the ProLand Statement of Work:

1. Where is agricultural development (large-scale commercial and subsistence) threatening forest and how does the threat from agriculture interact with other drivers of deforestation and degradation?
2. Where is agriculture markedly reducing carbon stocks, and are there areas where interventions to enable sustainable agriculture intensification are a priority for both sustainable landscapes and biodiversity conservation?

Description of work

A. Identification of carbon emissions hotspots for USAID GCC

Divide DRC into prioritized categories for reducing carbon emissions based on**:**

i. The amount of carbon/ha based on GFW carbon stock data (1) (Baccini et al., 2015)
ii. Past rates of net tree cover gain/loss (2), focusing on the past five years (Hansen et al. 2013)

Deliverables:

1. Map of new emerging hotspots, focusing on the last 3-5 years in areas where rates deforestation has been observed to be increasing
2. National Map of DRC showing net tree cover gain/lost over the past 12 years
3. National map of DRC showing carbon density (as of year 2000)
4. Overlay of CARPE priority landscapes, Pa and logging concessions with hotspots analysis
5. Geospatial data files created as part of the analysis

B. Drivers of carbon emissions hotspots

The team is most interested in agriculture's relative importance among other drivers of deforestation for this study. Recognizing that WRI does not currently have access to a GIS of smallholder agriculture, the team is interested in the correlation between hotspots of carbon loss, access, and concession and protected area boundaries, using the following GIS data layers (as existing data allows):

i. Access by public road, logging road, water,
ii. Protected Areas
iii. Logging concessions

Deliverables:

6. Carbon loss (for 2011 to 2014) by CARPE priority landscape – one map per landscape. Each map should show PA and logging concessions. PA should show the core area, inner periphery, outer periphery. Overlay access on map.
7. Summary table of the rate of tree cover loss nationally versus the rate of tree cover for PA, logging concessions and COMIFAC priority landscapes between 2000-2015.
8. Geospatial data files created as part of the analysis

Other deliverables:

These products should be accompanied by

9. a summary report that includes the following information:
    i. Description of the methods used
    ii. Description and discussion of the quality of the data used in the analysis
    iii. Description the strengths and weaknesses of the new products.
    iv. Narrative summary of the ability to analyze the rates of loss of sequestered above ground carbon using remote sensing data.
    v. Narrative summary of observed association between forest loss and access.

Due dates

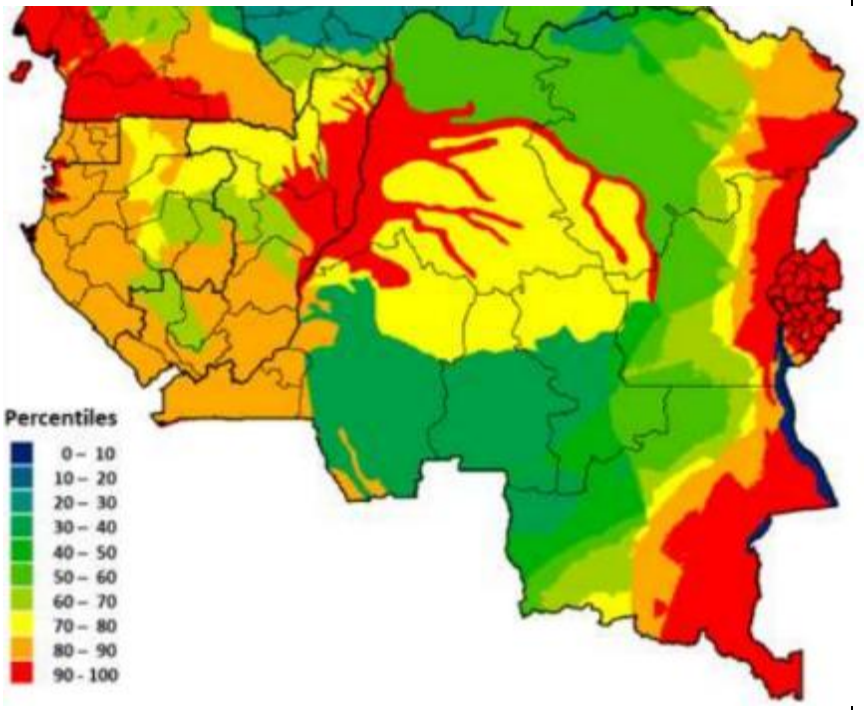
Draft Deliverables: March 9

Final deliverables: March 25

ANNEX E: MAPS

Map E-1. Biodiversity and TCL Trends

a. Composite species-ecoregion index, DRC

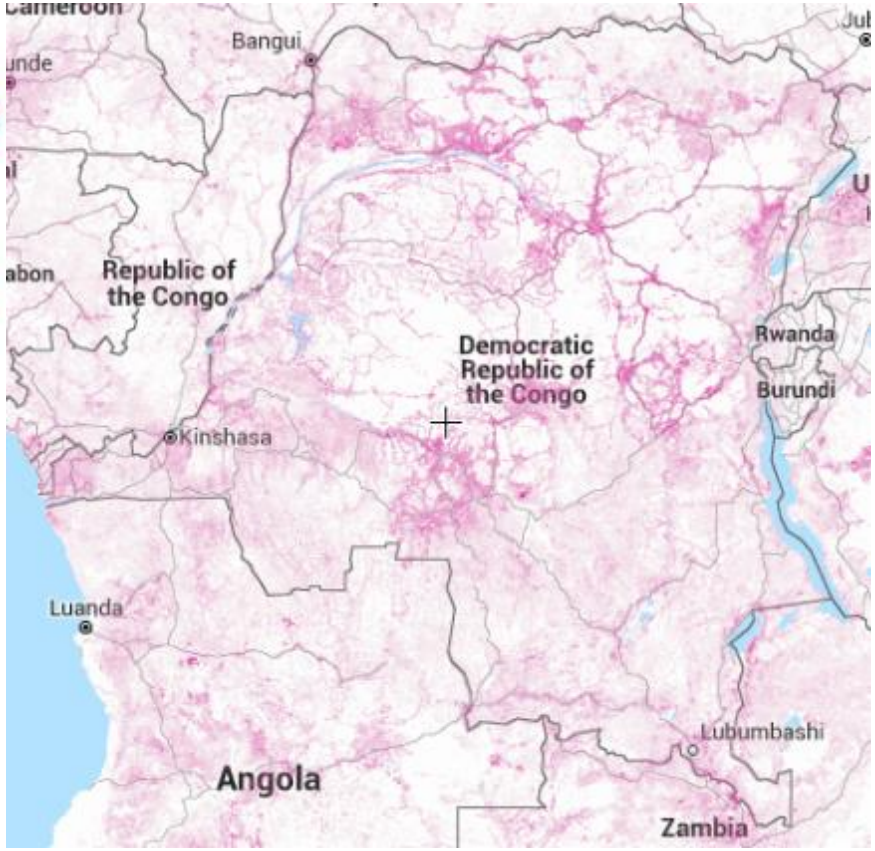


Source: World Bank 2016.

Smallholder agriculture, 2000-2010.

Source: Molinario et al, 2015. Black, gray, and white areas represent the rural complex.

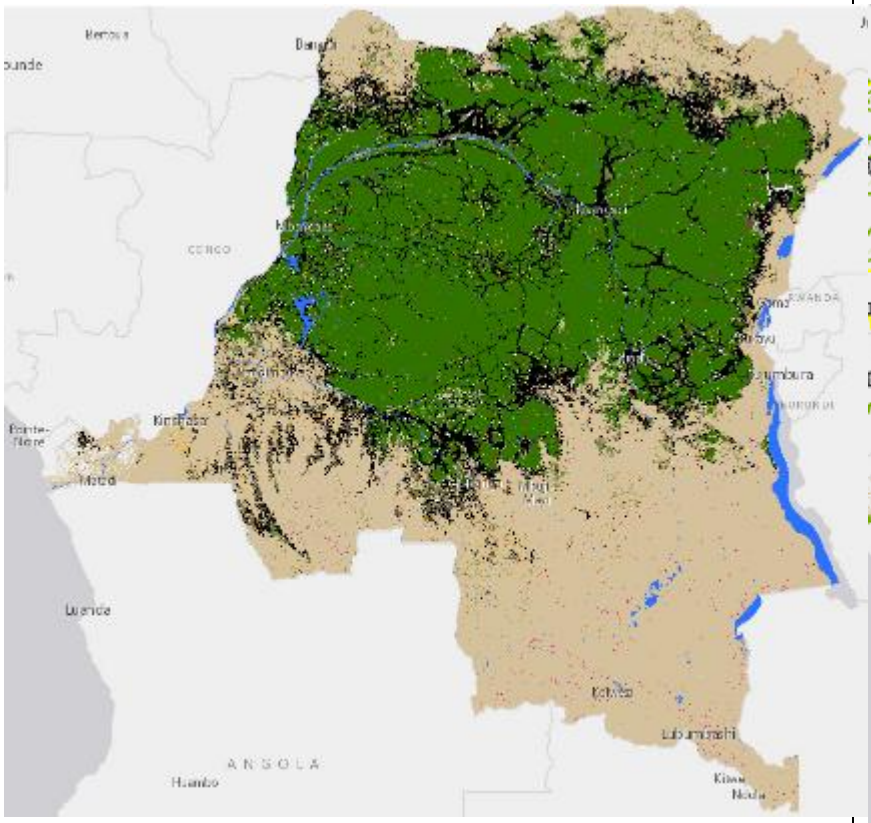
b. Tree cover loss, DRC



2001-2013, Greater than 30 percent canopy cover. Source: GFW interactive map. Accessed 4/8/2016

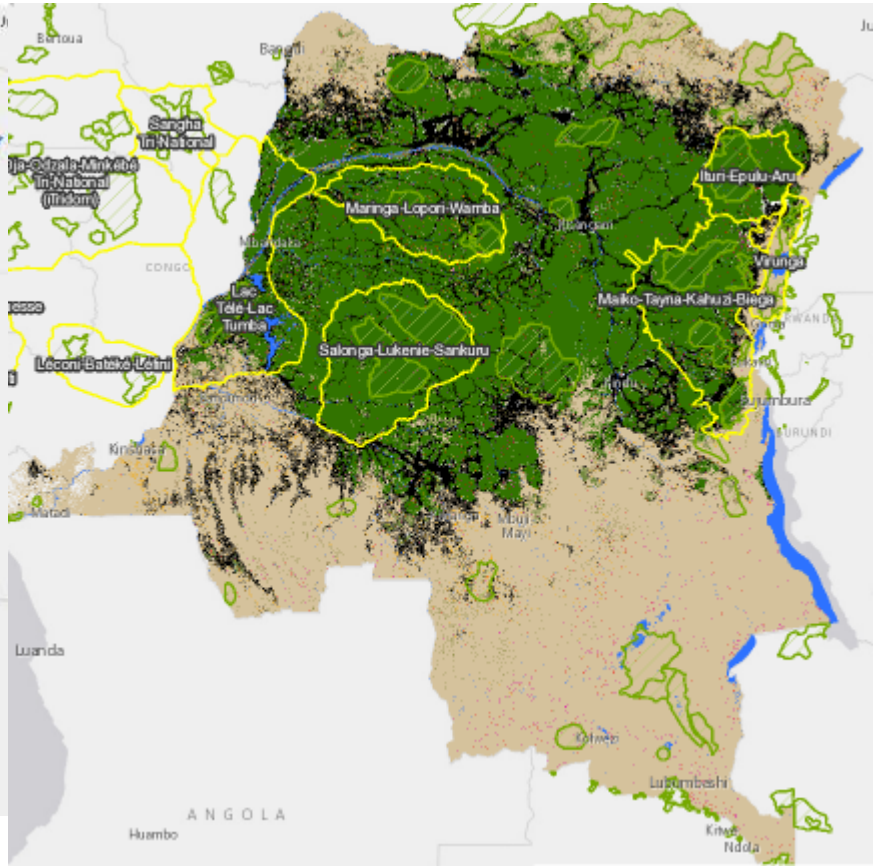
Smallholder agriculture, 2000-2010, with CARPE Landscapes

c. Molinario Rural Complex Summary Map



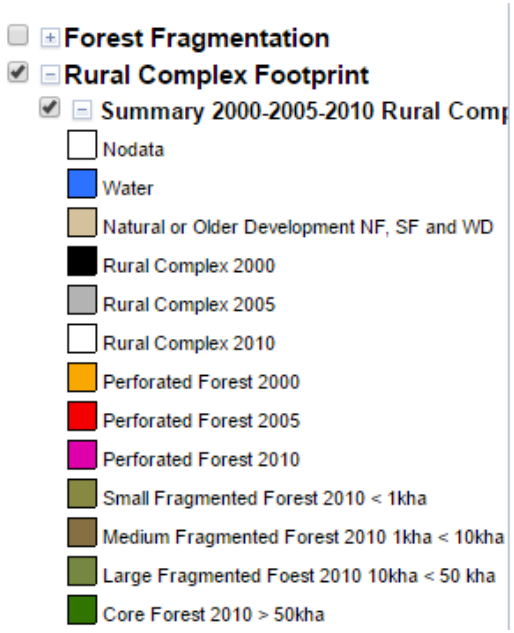
http://congo.iluci.org/shiftingcultivation.

d. Molinario Rural Complex Footprint, with CARPE Landscapes

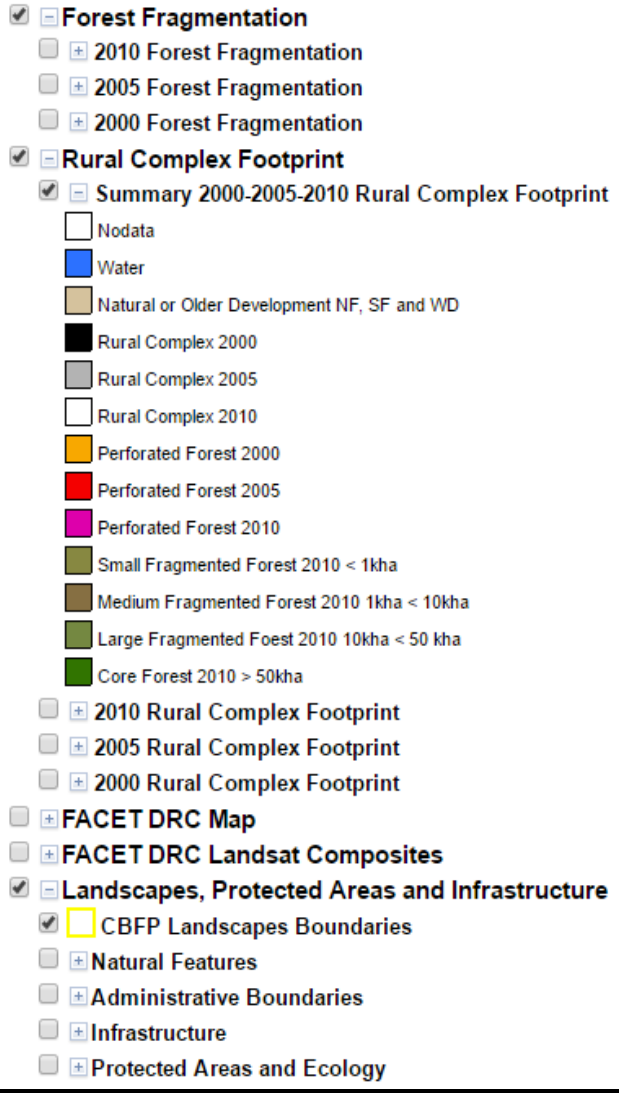


http://congo.iluci.org/shiftingcultivation/

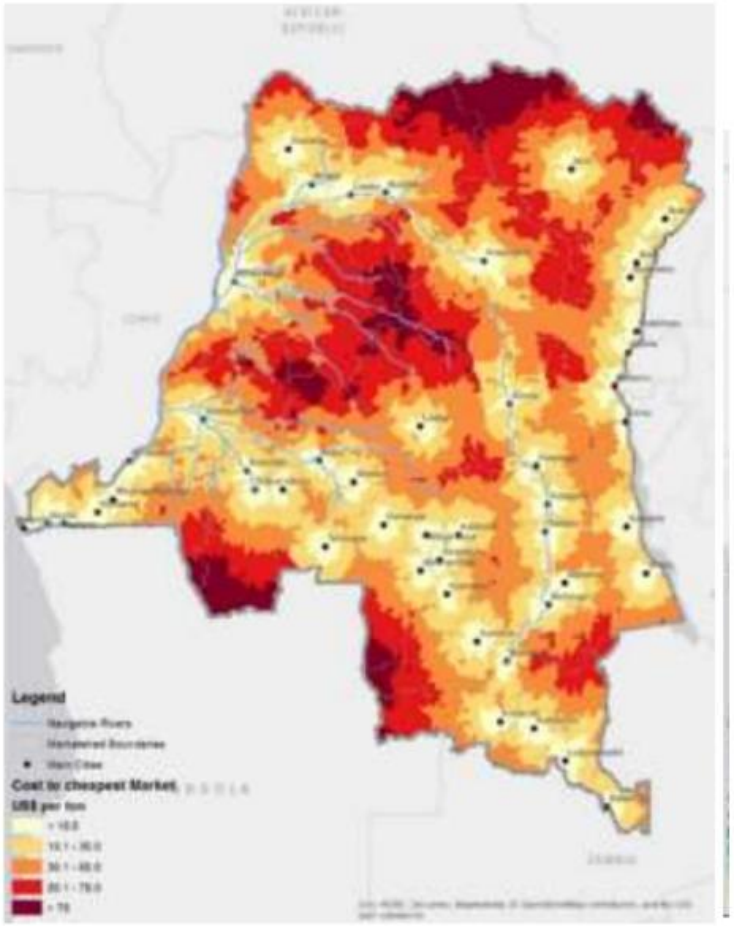
Key for Map E-1.C



Key for Map E-1D:

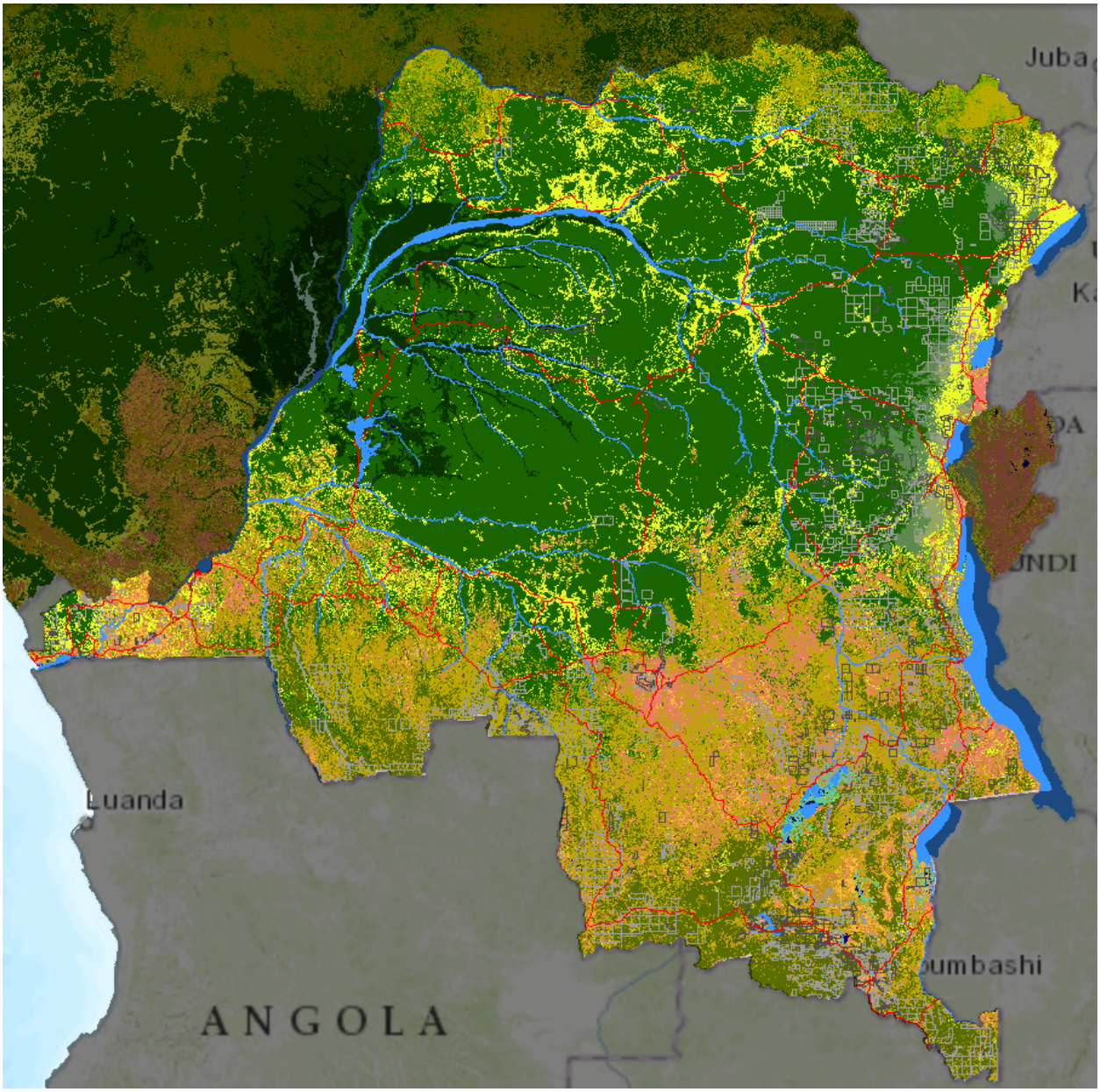


Map E-2. Transport Cost to Cheapest Market

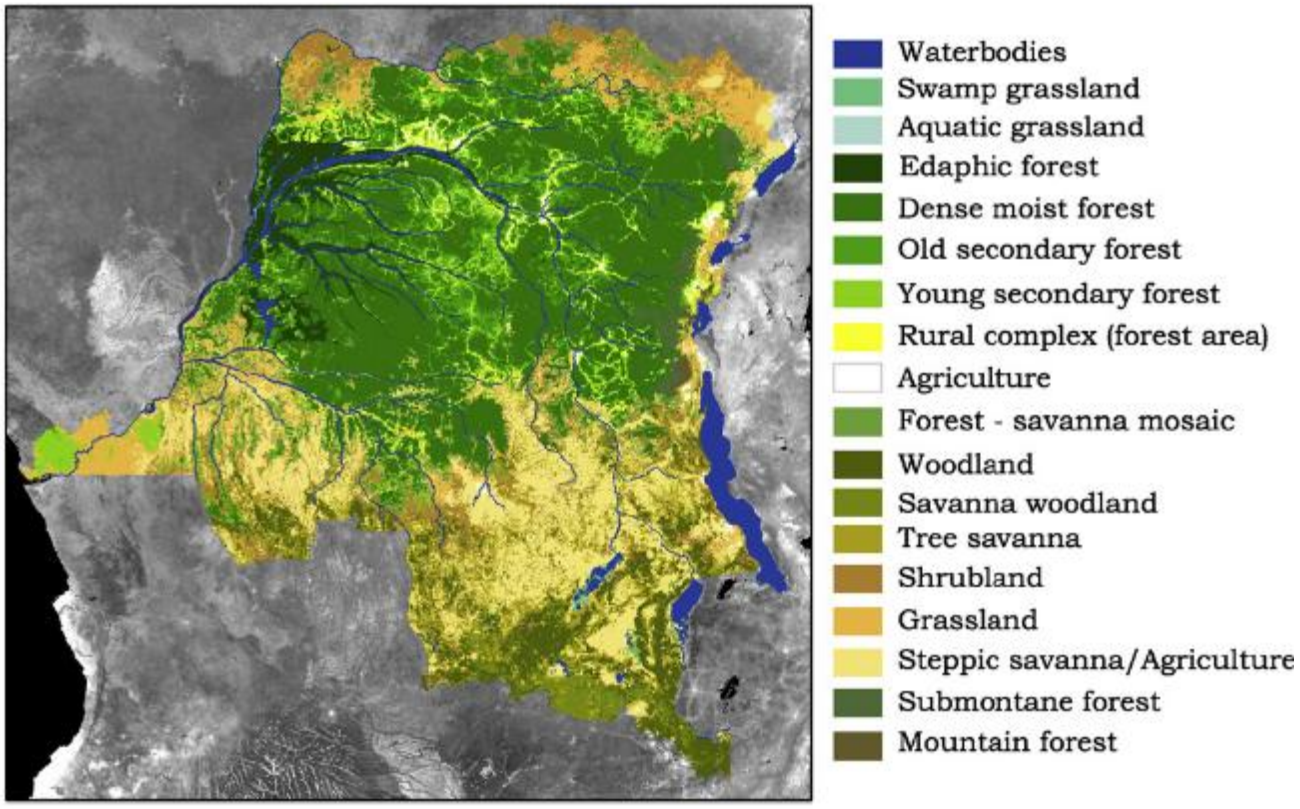


This map shows costs of transporting goods to the cheapest market from every location within the DRC (a market is defined as a city of at least 50,000 residents), using a multi-modal model with access to both roads and rivers. Source: World Bank 2016.

Map E-3. DRC Land Use Map Forest Atlas

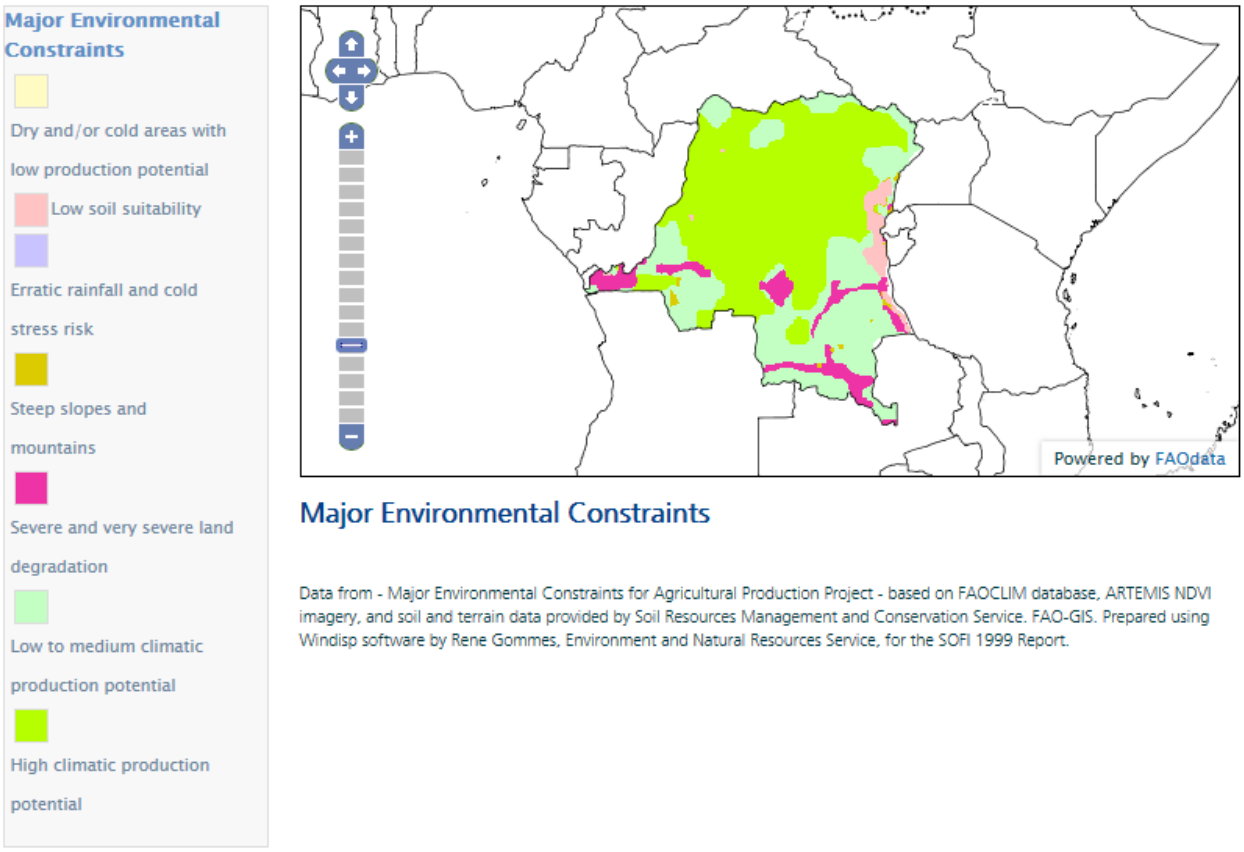


Map E-4. DRC Vegetative Land Cover



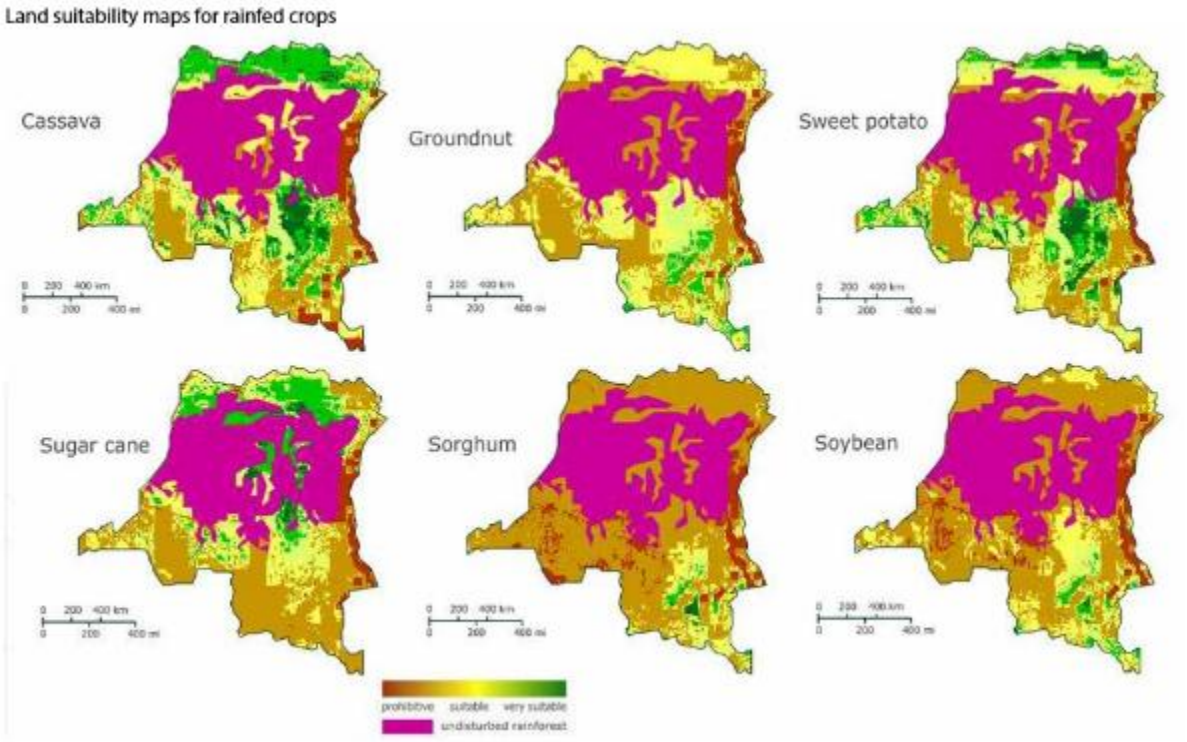
Vancutsem, C. et al. .2009. "Mapping and characterizing the vegetation types of the Democratic Republic of Congo using SPOT VEGETATION time series." *International Journal of Applied Earth Observation and Geoinformation*, 11(1), 62-76. https://www.researchgate.net/profile/Francois_Malaisse2/publication/220492152_Mapping_and_characterizing_the_vegetation_types_of_the_Democratic_Republic_of_Congo_using_SPOT_VEGETATION_time_series/links/02e7e529f604d54376000000.pdf

Map E-5. Environmental Constraints to Agricultural Production in DRC



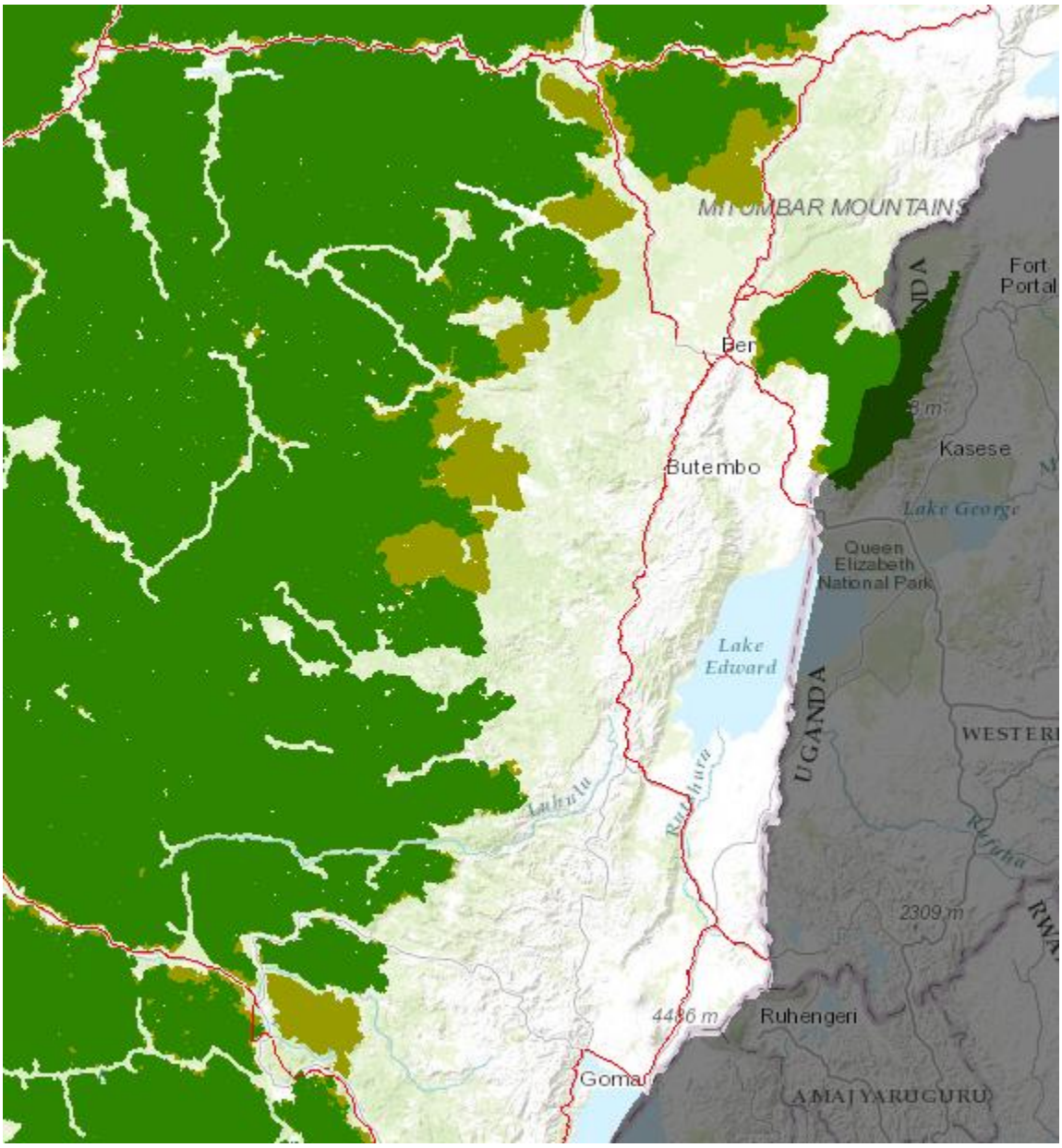
Source: FAO Country Profiles. Accessed 4/8/2016.
http://www.fao.org/countryprofiles/maps/map/en/?iso3=COD&mapID=604

Map E-6. FAO Land Suitability Maps for Six Crops



Source: Maps reproduced in GDRC, 2013, from the FAO Global Agro-Ecological Zone Database Portal http://gaez.fao.org/Main.html#

Map E-7. Intact Forest Landscapes Eastern Congo



Forest Atlas of DRC. Intact Forest Landscapes. http://cod.forest-atlas.org/map/#v=atlas&l=en&x=31.2286&y=0.2210&z=7

ANNEX F: ARRETE MINISTERIEL NO. 25

RÉPUBLIQUE DÉMOCRATIQUE DU CONGO
Ministère de l'Environnement, Conservation
de la Nature et Développement Durable

Le Ministre

Kinshasa, le

DFC ce 09/02/2016

ARRETE MINISTERIEL N°025 /CAB/MIN/ECN-DD/CJ/00/RBM/2016 DU 09 FEV 2016
PORTANT DISPOSITIONS SPECIFIQUES RELATIVES A LA GESTION ET A L'EXPLOITATION DE LA CONCESSION FORESTIERE DES COMMUNAUTES LOCALES

LE MINISTRE DE L'ENVIRONNEMENT, CONSERVATION DE LA NATURE ET DEVELOPPEMENT DURABLE,

Vu la Constitution, spécialement en son l'article 93 ;

Vu la Loi n° 011/2002 du 29 août 2002 portant Code forestier, spécialement en ses articles 22 et 111 à 113 ;

Vu l'Ordonnance n°15/075 du 25 septembre 2015 portant réaménagement technique du Gouvernement ;

Vu le Décret n°14/018 du 02 août 2014 fixant les modalités d'attribution des concessions forestières aux communautés locales, spécialement en ses articles 19 et 20 alinéa 4 ;

Vu l'Arrêté ministériel n°102/CAB/MIN/ECN-T/15/JEB/09 du 16 juin 2009 fixant les règles et formalités du contrôle forestier ;

Considérant les avis du Comité Technique de Validation des textes d'application du Code forestier institué par l'Arrêté ministériel n°009/CAB/MIN/EDD/03/09/BLN/2015 du 26 mars 2015, au cours de sa session du 05 au 07 novembre 2015 ;

Sur proposition du Secrétaire Général à l'Environnement, Conservation de la Nature et Développement Durable ;

ARRETE :

CHAPITRE IER : DES DISPOSITIONS GENERALES

Article 1er.-

Le présent arrêté fixe les dispositions spécifiques relatives à la gestion durable et à l'exploitation de la concession forestière de communauté locale.

A cette fin, il fixe notamment :

1. les modalités organisationnelles pour la gestion de la concession forestière de communauté locale ;
2. les mesures visant l'élaboration, l'approbation et l'exécution d'un plan simple de gestion tenant à la concession forestière ;
3. les règles relatives à l'exploitation et à l'utilisation des forêts concernées sous toutes les formes : coupe du bois d'œuvre, récolte des produits forestiers non ligneux, bois-énergie et produits de la faune sauvage et de la pêche, y compris la reconstitution du capital forestier de la concession ;

1

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4. les mesures relatives à la conservation de la biodiversité et à la valorisation des services environnementaux de la forêt concédée ;
5. les conditions selon lesquelles deux communautés locales peuvent, le cas échéant, s'associer en vue d'assurer la gestion commune de leur concession respective ;
6. les règles régissant la supervision et le contrôle de la gestion et de l'exploitation de la concession par l'administration en charge des forêts.

Article 2.-

Au sens du présent arrêté, on entend par :

1. **Bois-énergie :** le bois de feu et/ou le charbon de bois ;
2. **Bonne gouvernance :** une gestion rigoureuse fondée essentiellement sur les principes de transparence, d'égalité, d'équité et d'implication de l'ensemble des parties prenantes de la concession forestière, y compris la durabilité des ressources forestières concernées ;
3. **Cartographie participative :** la démarche comportant une série d'approches et de techniques consistant à fixer, au moyen d'une carte, de commun accord entre les parties prenantes concernées et de manière contradictoire, les limites des espaces occupés ou utilisés différemment par des usagers ayant des intérêts distincts ;
4. **Composante :** chacun des groupes socio-ethniques constituant les éléments d'une communauté locale : clans, lignées, familles, genre, peuples autochtones, groupes professionnels, etc. ;
5. **Concession forestière :** la concession forestière de communauté locale telle que prévue à l'article 2 du Décret n° 14/018 susvisé ;
6. **Contrat d'exploitation :** le contrat par lequel une communauté locale titulaire d'une concession confie l'exploitation d'une partie de celle-ci à une tierce personne, membre ou non de la communauté ;
7. **Foresterie communautaire :** l'ensemble des procédures, modalités et pratiques relatives à la gestion des forêts par les communautés locales en vue de leur développement socio-économique ;
8. **Partie prenante d'une communauté locale :** toute personne ou entité ayant un intérêt certain concernant la gouvernance de la concession forestière de communauté locale ;
9. **Permis de coupe communautaire :** permis délivré à une communauté locale pour opérer une coupe de bois d'œuvre dans sa concession.
10. **Personne-ressource :** toute personne ayant des connaissances avérées dans l'organisation, la gestion et/ou l'exploitation forestière ;
11. **Plan simple de gestion :** un document tenant lieu de plan d'aménagement forestier et destiné spécifiquement à appuyer la gestion durable de la concession forestière de communauté locale ;

12. Zone spécifique : l'un des espaces résultant de la division de la concession forestière et affectée à une activité particulière en fonction de la vocation de la terre concernée.

Article 3.-

Les us et coutumes visés par les dispositions du présent arrêté ne sont applicables que pour autant qu'ils ne soient pas contraires aux lois et à l'ordre public.

CHAPITRE II : DES MODALITES ORGANISATIONNELLES DE GESTION

Article 4.-

Toute communauté locale attributaire d'une concession forestière met en place des modalités organisationnelles relatives à la gestion de ladite concession.

A cette fin, elle a la latitude soit d'instituer une entité distincte de gestion, conformément à l'alinéa 1er de l'article 20 du Décret n°14/018 susvisé, soit d'adopter une organisation interne conformément aux dispositions des articles 5 à 18 du présent arrêté, tout en se référant aux us et coutumes locales.

Pour ce faire, elle peut être assistée par une organisation non gouvernementale environnementale agréée et/ou par une personne physique ayant les compétences requises.

Article 5.-

L'organisation interne visée à l'alinéa 2 de l'article 4 ci-dessus comporte : une assemblée communautaire, un comité local de gestion, un comité local de contrôle et de suivi-évaluation et un conseil des sages.

Section 1ère : Assemblée communautaire

Article 6.-

L'assemblée communautaire est l'organe de délibération et de prise de décision de la communauté locale.

Elle est compétente notamment pour :

1. Identifier les membres de la communauté locale ;
2. Adopter tout règlement lié à l'organisation et au fonctionnement des autres organes prévus à l'article 5 ci-dessus ;
3. Adopter les programmes périodiques d'activités relatives à la gestion et approuver les rapports y afférents, notamment celui ayant trait à la gestion financière ;
4. Décider des types d'activités à entreprendre collectivement ou individuellement par les membres de la communauté et valider en conséquence la délimitation de la concession par rapport aux activités retenues ;
5. Adopter, conformément à la réglementation en vigueur et aux us et coutumes, les règles pratiques de gestion et de contrôle de la concession ;

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6. Mettre en place les autres organes prévus à l'article 5 ci-dessus, notamment en désignant leurs membres à travers l'élection, la cooptation ou toute autre voie appropriée en vertu de la coutume locale. A cet effet, elle veille à l'équilibre des organes de la communauté tant dans leur représentativité que dans leur fonctionnement ;
7. Valider tout programme, projet ou plan lié à la gestion de la concession et au développement de la communauté locale ;
8. Elaborer et adopter le règlement spécifique relatif à la gestion du fond de développement communautaire prévu au chapitre VI du présent arrêté ;
9. Prendre toute décision généralement quelconque en matière de protection de l'environnement, d'utilisation et de gestion des ressources forestières.

Article 7.-

Sont membres de l'assemblée communautaire :

1. Le chef de la communauté, le(s) autre(s) représentant(s) coutumièrement attitré (s) de la communauté, selon les composantes de cette dernière, et les membres du conseil des sages ;
2. Toutes les personnes majeures unies par des liens de solidarité clanique ou parentale et établies sur le terroir de la communauté locale ;
3. Des représentants de tous groupes de personnes qui, liées à la communauté locale à un titre quelconque, sont établies traditionnellement dans le terroir visé ci-dessus.

Peuvent également être membres de l'assemblée communautaire les personnes physiques cooptées par les membres prévus aux points 1, 2 et 3 ci-dessus, notamment en raison de leur établissement effectif sur le terroir de la communauté et de leur volonté de contribuer d'une manière quelconque à son développement.

Article 8.-

Participent également aux réunions de l'assemblée communautaire sans voix délibérative, les membres des comités locaux de gestion et de contrôle et de suivi-évaluation prévus aux articles 9 à 14 ci-dessous.

Section 2 : Comité local de gestion

Article 9.-

Le comité local de gestion est l'organe exécutif et technique chargé d'assurer la gestion quotidienne de la concession forestière, conformément aux résolutions et orientations de l'assemblée communautaire auprès de laquelle il rend compte de ses actes.

Il assure également la gestion du fonds de développement communautaire prévu au chapitre VI du présent arrêté.

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Article 10.-

Le comité local de gestion est composé de neuf (9) membres au maximum désignés par l'assemblée communautaire. Cette composition est représentative de toutes les composantes de la communauté locale.

Le mandat du comité local de gestion est de cinq (5) ans renouvelables une fois.

Article 11.-

Au regard des tâches liées à son mandat, le comité local de gestion comporte un président, un vice-président, un trésorier, un responsable du fonds de développement communautaire, un secrétaire, un responsable technique, un chargé de communication et trois (3) conseillers.

Les attributions de chacun des membres prévus à l'alinéa ci-dessus sont fixées par le règlement intérieur pris par l'assemblée communautaire.

Section 3 : Comité local de contrôle et de suivi-évaluation

Article 12.-

Le comité local de contrôle et de suivi-évaluation est chargé d'assurer le suivi-évaluation des activités de gestion de la concession forestière.

Le suivi-évaluation porte notamment sur l'application conforme des mesures de gestion durables telles que déterminées par la communauté locale, les règles de gestion durable des ressources forestières, la tenue du fonds de développement communautaire prévu au chapitre VI du présent arrêté et le respect des modes de partages de revenus résultant de l'exploitation de la concession forestière.

Il vérifie les comptes de la communauté locale conformément à la réglementation en vigueur et à son règlement intérieur pris en vertu de l'article 6, point 2, du présent arrêté.

Article 13.-

Le Comité local de contrôle et de suivi-évaluation est composé des représentants des composantes de la communauté locale en raison d'une personne par composante et des personnes-ressources choisies en fonction de leur expertise.

Le nombre de personnes-ressources choisies ne peut être supérieur au quart (1/4) du nombre total de membres du comité.

Article 14.-

Le président du comité local de contrôle et de suivi-évaluation est désigné par l'assemblée communautaire parmi les représentants des composantes. Une personne-ressource ne peut accéder à la fonction de président.

L'organisation et le fonctionnement du comité local de contrôle et de suivi-évaluation sont conformes aux us et coutumes de la communauté locale et à son règlement intérieur tel qu'adopté par l'assemblée communautaire.

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Section 4 : Conseil des sages

Article 15.-

Le conseil des sages est un organe de consultation, de prévention et de règlement des conflits liés à la gestion, à l'utilisation et à l'exploitation de la concession et au partage des bénéfices qui en résultent.

Il rend ses avis sur la gestion de la concession, son exploitation, sur la mise en œuvre du plan simple de gestion ainsi que sur le partage des bénéfices qui en résultent.

La prévention et le règlement des conflits visés à l'alinéa 1 ci-dessus s'opèrent conformément à la réglementation en vigueur et aux us et coutumes de la communauté locale.

Article 16.-

Le conseil est composé de :

1. notables et acteurs sociaux de la communauté locale ;
2. toutes autres personnes désignées en fonction de leurs connaissances et conformément aux us et coutumes, par ceux repris au point 1 ci-dessus et dont le nombre ne peut être supérieur au quart (1/4) du nombre total des membres du conseil.

La composition du conseil est représentative de toutes les composantes de la communauté.

Article 17.-

Le conseil est présidé par un notable choisi parmi les chefs de clan, lignée, famille, village, etc.

L'organisation et le fonctionnement du conseil sont conformes aux us et coutumes de la communauté locale et au règlement intérieur spécifique, tel que prévu au point 2 de l'article 6 ci-dessus, sans préjudice des dispositions légales et réglementaires en vigueur.

Article 18.-:

Tout différend entre les membres d'une communauté locale ou entre différentes communautés locales portant sur la concession forestière est résolu suivant les us et coutumes, sans préjudice des dispositions légales et réglementaires en vigueur.

Section 5 : Entité distincte de gestion

Article 19.-

Dans l'hypothèse où la communauté locale attributaire d'une concession forestière opte pour l'institution d'une entité de gestion distincte prescrite par l'article 20, alinéa 1er du Décret n°14/018 susvisé, elle s'assure que les attributions du comité local des gestion et du

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comité local de contrôle et de suivi-évaluation sont respectivement assumées par les organes statutaires de l'entité précitée.

Toutefois, quel que soit le type adopté, l'assemblée communautaire et le conseil des sages prévus aux sections 1ère et 4 ci-dessus demeurent et conservent leurs attributions.

Section 6 : Responsabilité du chef de la communauté locale

Article 20.-

Outre les pouvoirs qui lui sont reconnus par la loi et la coutume, le chef de la communauté locale veille à la bonne gouvernance de la concession forestière.

A ce titre, il exerce notamment les missions suivantes :

1. conduire le processus de la mise en place des modalités organisationnelles relatives à la gestion de la concession forestière avec l'appui des notables et des chefs d'opinion de la communauté locale conformément à la réglementation en vigueur et aux us et coutumes locales ;
2. assurer en collaboration avec le conseil des sages prévus aux articles 15 à 18 ci-dessus la prévention et le règlement des conflits conformément à la législation en vigueur et aux us et coutumes de la communauté ;
3. veiller, notamment par l'intermédiaire du comité de contrôle et de suivi-évaluation, à l'application des dispositions légales et réglementaires relatives à la gestion forestière, en particulier celles du présent arrêté, ainsi qu'au respect des règles et mesures consignées dans le plan simple de gestion.

Article 21.-

Le chef de la communauté locale ne peut, en aucun cas et d'aucune manière, se prévaloir de son titre et de ses fonctions pour revendiquer à son profit personnel et exclusif les revenus provenant de la gestion et de l'exploitation des ressources forestières de la communauté locale.

L'alinéa ci-dessus ne concerne pas les droits revenant au chef de la communauté en vertu de la coutume.

CHAPITRE III : DU PLAN SIMPLE DE GESTION DE LA CONCESSION

Section 1ère : Elaboration et contenu du plan simple de gestion

Article 22.-

La gestion et l'exploitation de la concession forestière sont réalisées suivant un plan simple de gestion élaboré par la communauté locale avec l'appui de l'administration forestière locale ou toute autre personne physique ou morale ayant les compétences requises.

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Le plan visé ci-dessus est élaboré conformément à un guide opérationnel spécifique établi par l'administration centrale chargée des forêts.

Article 23.-

Le plan simple de gestion comporte notamment :

1. La division de la concession en zones spécifiques et l'affectation de celles-ci à des activités à y entreprendre, selon leur vocation première ;
2. La programmation, basée sur un inventaire multi-ressource simplifié, dans le temps et l'espace, de l'ensemble des activités concernées suivant les objectifs de satisfaction de différents besoins de la communauté locale et de ses membres, y compris ceux de développement ;
3. Le rapport d'enquête socio-économique comportant notamment les éléments relatifs à l'identification des strates de la population concernée, les différentes activités exercées dans la concession forestière ainsi que ses bescins socio-culturelles et de développement ;
4. La définition et la description des mesures de gestion, en particulier celles relevant des us et coutumes de la communauté ;
5. Les modalités de l'exercice individuel des droits d'usage par les membres de la communauté ;
6. L'indication des règles spécifiques relatives à la conservation de la nature et à la protection de l'environnement telles que prévues par la législation en vigueur et/ou les us et coutumes de la communauté.

Le plan simple de gestion fixe les modalités d'exercice des droits d'usage forestiers.

Article 24 :

Si, en outre, l'une des zones spécifiques est affectée à l'exploitation des bois d'œuvre, le plan simple de gestion prévoit :

1. une carte ou un croquis reprenant l'emplacement des arbres exploitables et de ceux à protéger tels que les arbres semenciers, les arbres fruitiers, ceux à chenilles et les plantes médicinales ;
2. les quantités ou volumes des bois à prélever annuellement sur une période maximale de cinq (5) ans.

Article 25.-

Le plan simple de gestion prend en compte les occupations et les usages d'espaces par toutes les composantes de la communauté locale.

En cas de conflit concernant les limites d'une zone spécifique, notamment par rapport aux occupations et usages susvisés, celle-ci est exclue du plan simple de gestion, en attendant la résolution dudit conflit par le conseil des sages.

Article 26.-

Le plan simple de gestion fait l'objet d'une évaluation annuelle facultative et d'une évaluation quinquennale obligatoire.

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Une évaluation annuelle peut, le cas échéant, donner lieu à une révision annuelle notamment, lorsqu'il s'agit de la modification de l'espace de la concession forestière particulièrement quand il s'agit de la résolution d'un conflit, telle que prévue à l'article 25 ci-dessus.

Une évaluation quinquennale peut donner lieu à une révision portant sur un ensemble des mesures de gestion de la concession forestière.

Section 2 : Approbation du plan simple de gestion

Article 27.-

Après sa validation par l'assemblée communautaire, le plan simple de gestion de la concession forestière est approuvé, selon le cas, par le chef de secteur, le chef de chefferie ou le bourgmestre urbano-rural du ressort de la forêt concernée suivant les modalités prévues aux articles 28 à 32 ci-dessous.

Article 28.-

La demande en obtention de l'approbation du plan simple de gestion est introduite auprès du service local chargé des forêts du ressort, moyennant une lettre écrite dûment signée, selon le cas, par le président du comité local de gestion ou le responsable de l'entité distincte de gestion prévus respectivement aux articles 9 à 11 et 21 ci-dessus. Il y est joint le plan simple de gestion reproduit en quatre (4) exemplaires.

Si la communauté locale requérante fait partie d'une autre communauté locale dotée du statut d'entité décentralisée, le plan simple de gestion est, au préalable, visé par le chef de cette dernière.

Article 29.-

Au plus tard sept (7) jours ouvrables après réception du dossier de la demande prévue à l'article précédent, le service local compétent vérifie la conformité du processus d'élaboration du plan simple de gestion et celle de son contenu conformément aux articles 22 à 25, et le cas échéant, le visa du chef de l'entité décentralisée tel que prévu à l'article 28 ci-dessus.

Article 30.-

A l'issue de l'examen de la requête, le service concerné soumet à la signature du chef de secteur un projet de lettre d'approbation du plan simple de gestion.

Dès l'approbation dudit plan le chef du service susvisé en expédie l'original à la communauté locale requérante tout en transmettant un exemplaire au service provincial des forêts du ressort.

Article 31.-

Si le chef de secteur, le chef de chefferie ou le bourgmestre urbano-rural, selon le cas, n'a pas réagi dans les quinze (15) jours ouvrables à compter de la date de réception de la demande par le service local prévu ci-dessus, le plan simple de gestion est réputé approuvé.

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Dans ce cas, la communauté locale, à travers le comité de gestion ou l'entité distincte de gestion, selon le cas, en notifie sans délai le service local forestier par écrit avec un accusé de réception.

Une copie de la lettre de notification est transmise au service provincial chargé des forêts du ressort.

Article 32.-

L'approbation confère au plan simple de gestion un caractère officiel rendant son exécution obligatoire pour la communauté locale et ses membres et opposable envers des tiers.

En cas de révision du plan simple de gestion, telle que prévue à l'article 26 ci-dessus, la version révisée n'est exécutoire qu'après son approbation.

Article 33.-

L'exécution du plan simple de gestion fait l'objet de contrôle par le service forestier compétent conformément à la réglementation en vigueur en cette matière sans préjudice des dispositions des articles 78 à 80 du présent arrêté.

CHAPITRE IV : DE L'EXPLOITATION DE LA CONCESSION FORESTIERE

Section 1ère : Conditions générales

Article 34.-

La communauté locale peut exploiter sa concession forestière soit par elle-même, soit par l'intermédiaire d'exploitants artisanaux, pour la coupe de bois d'œuvre, et d'autres tiers, pour tout autre type d'exploitation, moyennant la conclusion d'un contrat d'exploitation.

En fonction de ses besoins de développement, une communauté locale peut affecter sa concession à une ou plusieurs activités compatibles économiquement, socialement et écologiquement viables sur le plan tant du développement que de la durabilité des forêts de sa concession.

Article 35.-

Les exploitants artisanaux et les tiers prévus à l'article 34 ci-dessus ne peuvent opérer dans la concession forestière que s'ils remplissent, au préalable, les conditions légales relatives à leur profession et à l'exercice de l'activité faisant l'objet du contrat tel que prévu à l'article précédent.

Article 36.-

Tout contrat d'exploitation est négocié et conclu avec le comité local de gestion ou l'entité distincte de gestion, selon le cas.

Toutefois, il ne produit ses effets qu'après sa validation par le conseil communautaire et son approbation par l'administration forestière locale du ressort.

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Aucun contrat d'exploitation ne peut se rapporter à une activité exercée sur un espace situé hors d'une concession forestière.

Article 37.-

La concession forestière ne peut faire l'objet d'une division au profit des titres individuels. Toutefois, chaque membre de la communauté peut, à des fins commerciales et moyennant un contrat y afférent conclu, selon le cas, avec le comité de gestion ou l'entité distincte de gestion, être autorisé à exploiter une ressource de la concession forestière.

Article 38.-

Les contrats prévus par les dispositions des articles 34, 37, 51 et 66 du présent arrêté sont conformes au modèle s'y rapportant élaboré et publié par l'administration forestière centrale.

Ils n'entrent en vigueur qu'après leur approbation par l'administration forestière locale du ressort.

Article 39.-

Tout membre d'une communauté locale peut, conformément à l'article 40 ci-dessous, prélever dans une concession forestière de sa communauté, à titre individuel et pour son usage domestique, du bois d'œuvre, du bois-énergie, des produits forestiers non ligneux.

Article 40.-

La fixation des modalités d'exercice individuel des droits d'usage forestiers font l'objet d'un débat contradictoire au sein de l'assemblée communautaire.

Ces modalités sont consignées dans le plan simple de gestion, y compris les mesures éventuelles de conservation de chaque ressource forestière concernée.

Section 2 : Exploitation du bois d'œuvre et des produits forestiers non ligneux.

Article 41.-

La coupe du bois d'œuvre dans la concession forestière par la communauté locale elle-même est subordonnée à l'obtention préalable d'un permis de coupe communautaire dont le modèle-est élaboré par l'administration centrale en charge des forêts.

Etabli au nom de la communauté locale, le permis de coupe susvisé est délivré par le chef de secteur, le chef de chefferie ou le bourgmestre urbano-rural du ressort de la concession sur la base du résultat de l'inventaire sommaire tel que consigné dans le plan simple de gestion et moyennant payement d'une taxe dont le taux est fixé conformément à la règlementation en vigueur.

Il est valable pour une période d'un (1) an, allant du 1er janvier au 31 décembre.

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Article 42.-

La demande de permis de coupe communautaire, à laquelle sont joints le résultat de l'inventaire, et le cas échéant, le contrat d'exploitation prévu à l'alinéa 1er de l'article 34 ci-dessus, est déposée au service local des forêts, lequel est chargé de l'examiner dans les sept (7) jours ouvrables qui suivent la date de sa réception.

L'examen précité porte notamment sur :

1. la conformité de la demande, particulièrement quant aux essences et au volume de bois à prélever au regard du résultat de l'inventaire ;
2. la conformité du contrat d'exploitation avec les dispositions des articles 36 et 38 du présent arrêté ainsi qu'avec les objectifs du développement socio-économique de la communauté locale concernée.

Article 43.-

Si la vérification du dossier de la demande visée à l'article 42 ci-dessus aboutit à l'acceptation de cette dernière, le chef du service local chargé des forêts prépare le permis de coupe et le transmet pour signature au chef de secteur, chef de chefferie ou bourgmestre urbano-rural.

Si le dossier précité comporte un contrat d'exploitation, Il est transmis sans délai à l'administration provinciale des forêts du ressort pour son approbation.

Article 44.-

La demande est d'office rejetée si le dossier n'est pas conforme concernant les essences et le volume des bois à prélever et/ou si le contrat d'exploitation y annexé comporte une quelconque irrégularité.

Dans ce cas, la demande est reformulée sur la base des corrections requises et réintroduite conformément à l'article 42 ci-dessus.

Article 45.-

L'administration provinciale des forêts prévue à l'article 43 ci-dessus dispose de sept (7) jours ouvrables pour examiner le contrat d'exploitation, l'approuver et le retourner au service local concerné.

L'approbation est faite moyennant la signature du chef de l'administration précitée apposée sur la dernière page du document du contrat d'exploitation suivie de la mention : « Vu et approuvé ». Celle-ci est assortie de l'identité complète de l'autorité concernée et du cachet de service émetteur. Il est mis un paraphe sur chacune des autres pages du document.

Le chef du service local des forêts, qui reçoit le dossier de demande visée à l'article 42 ci-dessus y compris le contrat d'exploitation dûment approuvé, prépare le permis de coupe communautaire et le soumet au chef de secteur ou chef de chefferie ou bourgmestre urbano-rural pour sa signature.

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Article 46.-

Le chef de secteur, le chef de chefferie ou le bourgmestre urbano-rural délivre le permis de coupe communautaire dans un délai ne dépassant vingt-et-un (21) jours ouvrables à compter de la date de réception de la demande par le service local des forêts.

Si à l'expiration du délai prévu ci-dessus, il ne réagit pas, l'approbation du contrat et la délivrance du permis sont acquises d'office. Dans ce cas, la communauté locale requérante, à travers son comité local de gestion ou son entité distincte de gestion, en informe l'autorité concernée par écrit avec un accusé de réception.

Aussi, outre l'accusé de réception de la demande prévue aux articles 44 et 45 ci-dessus, la lettre de notification et l'accusé de réception, dont le service provincial chargé des forêts et l'administrateur de territoire sont dument tenus informés, tiennent lieu de permis de coupe communautaire.

Article 47.-

La production du bois d'œuvre dans la concession forestière ne peut s'opérer qu'avec les matériels ci-après : une tronçonneuse, une scie de long et un tir-fort.

Article 48.-

Tout arbre abattu comme bois d'œuvre dans la concession forestière est mentionnée sur une fiche d'exploitation fournie par l'administration chargée des forêts.

Article 49.-

Sont interdites :

1. la vente sur pieds du bois se trouvant dans la concession forestière ;
2. l'exportation sous forme de grumes de tout bois prélevé dans la concession ;
3. sous peine de nullité d'office, tout contrat conclu avec un exploitant industriel et visant le prélèvement du bois d'œuvre dans la concession forestière.

Article 50.-

Conformément aux dispositions règlementaires en vigueur, appliquées *mutatis mutandis*, la communauté locale procède à la déclaration trimestrielle de sa production des bois d'œuvre auprès du service forestier du secteur, de la chefferie ou de la commune urbano-rurale de ressort de la concession.

Article 51.-

La communauté locale peut conclure un contrat avec tout Congolais, personne physique ou morale, pour la récolte, à titre commercial ou de recherche, de tout produit forestier non ligneux trouvé dans sa concession.

Le contrat susvisé n'entre en vigueur qu'après son approbation par l'administration forestière locale du ressort.

Il est conforme au modèle fixé par l'administration conformément aux dispositions de l'article 38 ci-dessus.

En outre, la personne contractante est tenue d'obtenir au préalable un permis de récolte spécifique prévu par la réglementation en vigueur.

Section 3 : Exploitation du bois-énergie

Article 52.-

Toute coupe de bois-énergie pratiquée, à titre commercial, par un membre de la communauté ou une tierce personne dans la concession forestière est soumise aux conditions suivantes :

1. l'érection préalable dans la concession d'une zone spécifique affectée à ladite activité et sa prise en compte dans le plan simple de gestion prévu au chapitre III du présent arrêté ;
2. la détention par l'exploitant concerné d'un permis de coupe de bois de feu et de charbon de bois prévu par la réglementation en vigueur ;
3. la conclusion d'un contrat d'exploitation conclu entre le susdit exploitant et la communauté locale représentée, selon le cas, par le comité de gestion ou l'entité distincte de gestion de la concession. Ce contrat fait l'objet d'une approbation conformément à l'article 45 ci-dessus.

Article 53.-

Il est interdit au titulaire du permis visé au point 2 de l'article 52 ci-dessus de couper des arbres d'essences classées en vertu de la réglementation en vigueur comme bois d'œuvre à valeur marchande, quel qu'en soit le diamètre.

Toutefois, les dispositions du 1er alinéa ci-dessus ne sont pas d'application lorsqu'il s'agit de valoriser les déchets et les bois morts des essences concernées.

Article 54.-

Le volume du bois prélevé et/ou la quantité de charbon de bois obtenue en vertu d'un permis de coupe des bois feu et de charbon de bois sont déclarés à la fin de chaque trimestre de l'exercice en cours auprès du service forestier du secteur, de la chefferie ou de la commune urbano-rurale du ressort.

A cette fin, le déclarant remplit un formulaire ad hoc tenu et fourni par le service susvisé et où sont mentionnées les informations relatives aux éléments suivants :

1. l'identification complète du déclarant ;
2. l'identité de la communauté locale attributaire de la concession forestière d'origine des bois exploités ;
3. le volume, poids ou quantité des produits concernés ;
4. le lieu de prélèvement des produits ;
5. les références du permis : date de délivrance, numéro d'ordre, période de validité ;

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6. les références du contrat d'exploitation : date de signature et d'expiration, date et autorité d'approbation, trimestre et année concernés, numéro d'ordre.

Section 4 : Exploitation de la faune sauvage et des ressources halieutiques

Article 55.-

Les activités de chasse et de pêche sont exercées dans la concession forestière conformément aux conditions particulières prévues par les dispositions des articles 56 à 58 ci-dessous, sous réserve du respect strict de la législation sur la chasse et sur la pêche ainsi que des us et coutumes.

Article 56.-

En fonction du potentiel de la faune sauvage et/ou de la ressource halieutique hébergée par sa concession, la communauté locale peut, à travers le plan simple de gestion, affecter une des zones spécifiques à l'exercice des activités de la chasse et/ou de la pêche.

Toutefois, avant l'ouverture de la zone précitée aux activités précitées, la communauté locale est tenue de procéder à l'inventaire sommaire des ressources concernées pour s'assurer que leur potentiel est suffisant pour soutenir une exploitation durable.

Les résultats de l'inventaire sont mentionnés dans le plan simple de gestion de la concession.

Article 57.-

Outre ce qui est prescrit à l'article 56 ci-dessus, la pratique de la chasse par les membres de la communauté et/ ou des tiers, n'est autorisée que moyennant détention, soit d'un permis rural de chasse ou d'un permis de capture commerciale, pour une personne physique, soit d'un permis collectif de chasse, pour un groupe de personnes.

Le permis précité est délivré par l'administration du territoire du ressort sur présentation d'un agrément écrit de la communauté.
Toutefois, s'il s'agit d'une capture commerciale, le titulaire est tenu, en outre, de conclure un contrat spécifique avec la communauté.

Dans tous les cas, la chasse s'opère sous la responsabilité de la communauté locale.

Article 58.-

Les dispositions de l'article 57 ci-dessus s'appliquent *mutatis mutandis* à la pêche pratiquée par les membres de la communauté locale.

CHAPITRE V : RECONSTITUTION DU CAPITAL FORESTIER

Article 59.-

La communauté locale veille, conformément à la réglementation en vigueur, à la reconstitution du capital forestier de sa concession forestière.

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A cette fin, elle est tenue de :

1. favoriser la régénération naturelle en veillant à l'abandon sur l'aire de coupe des arbres semenciers sur pieds et à la pratique des éclaircis des arbres d'avenir ;
2. interdire la pratique des déboisements et des coupes rases sur l'aire de coupe de bois d'œuvre ;
3. procéder à des travaux périodiques de reboisement, notamment par des exploitants de bois-énergie tenus de planter des essences à croissance rapide pour compenser les coupes des bois opérées dans la concession forestière ;
4. promouvoir dans la concession forestière la pratique de l'agroforesterie.

Article 60.-

Tout plan simple de gestion ne comportant pas d'indication spécifique sur le prescrit de l'article 59 ci-dessus ne peut être approuvé par le chef de secteur, le chef de chefferie ou le bourgmestre urbano-rural du ressort, selon le cas.

Article 61.-

Pour la réalisation des travaux de reboisement de sa concession forestière, la communauté locale peut, conformément aux dispositions légales et réglementaires en vigueur, solliciter et obtenir l'encadrement et la fourniture de plantes et de graines d'essences forestières auprès de l'administration provinciale des forêts et/ou un financement approprié auprès du Fonds forestier National.

CHAPITRE VI : DU FONDS DE DEVELOPPEMENT COMMUNAUTAIRE

Article 62. -

Toute communauté locale attributaire d'une concession forestière est tenue de mettre en place un fonds de développement communautaire alimenté principalement par les revenus issus de différentes activités liées à l'exploitation de sa concession forestière.

Ce fonds peut également être alimenté par d'autres apports dont notamment les aides extérieures destinées à la communauté locale.

Article 63.-

La gestion du fonds de développement communautaire est assurée par le comité local de gestion ou l'entité distincte de gestion, conformément à la réglementation en vigueur et à un règlement spécifique adopté par l'assemblée communautaire prévue aux articles 6 à 8 du présent arrêté.

Article 64.-

Le règlement prévu à l'article 63 ci-dessus fixe également les modalités relatives à l'affectation et au partage des revenus issus de l'exploitation de la concession forestière.

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CHAPITRE VII : DE LA CONSERVATION DE LA NATURE ET DES SERVICES ENVIRONNEMETAUX

Section 1ère : Conservation de la nature

Article 65.-

Pour pouvoir contribuer au programme national de la conservation de la diversité biologique, la communauté locale peut, conformément à la législation en vigueur et à ses propres us et coutumes, affecter tout ou une partie de sa concession forestière à la conservation et à la protection de la diversité biologique.

Article 66.-

La zone affectée à la conservation peut être gérée par la communauté, soit par elle-même soit à travers l'entité de gestion prévue au chapitre II ci-dessus.

Toutefois, la communauté locale peut, à l'aide d'un contrat de gestion conclu entre, selon le cas, son comité locale de gestion ou l'entité distincte de gestion et une personne, physique ou morale, consentir à une cogestion de la zone susvisée.

Avant son entrée en vigueur le contrat de gestion visé à l'alinéa 2 ci-dessus fait l'objet d'une approbation préalable par l'administration forestière locale du ressort.

Dans tous les cas, la gestion de l'activité concernée est réalisée conformément au plan simple de gestion de la concession forestière.

Section 2 : Services environnementaux

Article 67.-

La communauté locale peut, conformément au prescrit de l'article 23 ci-dessus, consacrer une partie ou la totalité de sa concession forestière au paiement des services environnementaux, notamment la séquestration de carbone et la protection des sites.

De même, elle peut affecter une partie ou la totalité de sa concession forestière à l'exercice des activités d'écotourisme ou de bio-prospection, sans préjudice des dispositions légales spécifiques en vigueur.

Article 68.-

Aux fins de dispositions de l'article 67 ci-dessus, la communauté locale peut, conformément à la législation en vigueur, se faire assister par un service public compétent ou une organisation non gouvernementale ayant les capacités techniques requises.

L'organisation visée ci-dessus remplit, au préalable, toutes les conditions légalement requises.

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CHAPITRE VIII : DE LA MISE EN COMMUN DES CONCESSIONS FORESTIERES

Article 69 :

Sans préjudice des conditions prévues par les articles 70 à 72 ci-après, deux communautés locales peuvent, s'associer pour la gestion commune de leurs concessions si :

1. les concessions forestières concernées leur ont été régulièrement et préalablement attribuées ;
2. elles sont contiguës de façon à faciliter les opérations de leur aménagement commun.

Article 70.-

L'association susvisée à l'article précédent est établie par la conclusion d'un accord écrit entre les communautés locales concernées, lequel est entériné par l'administration provinciale en charge des forêts.

L'accord précité définit notamment son objet, les objectifs poursuivis, la nature de l'exploitation envisagée, les droits et les obligations des parties, le principe d'aménagement commun des concessions concernées, les modalités de partage des revenus qui en découleront, les mécanismes de gestion des conflits ainsi que les modalités de collaboration entre les chefs des communautés locales concernées.

Article 71.-

Toute communauté locale est libre de se désengager de l'association prévue aux articles 69 et 70 ci-dessus moyennant un préavis d'une (1) année motivé et notifié à l'autre communauté locale.

L'administration forestière locale du ressort en est dûment tenue informée.

Article 72.-

La gestion du projet commun de gestion et d'exploitation des concessions forestières concernées donne lieu à la mise en place des organes de gestion commune conformément au chapitre II du présent arrêté.

CHAPITRE IX : DE LA SUPERVISION ADMINISTRATIVE ET DU CONTROLE FORESTIER

Section 1ère : Supervision administrative

Article 73.-

L'Administration en charge des forêts assure la supervision de la gestion de la concession forestière de communauté locale.

Elle agit à travers ses services compétents tant au niveau central, qu'à celui provincial, territorial et local, conformément à la réglementation en vigueur et aux dispositions prévues ci-dessous.

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Article 74.-

Dans le cadre de la supervision visée à l'article 73 ci-dessus l'administration centrale des forêts est chargée notamment de :

1. définir et mettre en œuvre une stratégie nationale relative à la foresterie communautaire ;
2. faciliter le développement de la foresterie communautaire par la promotion des méthodes et des pratiques garantissant la bonne gouvernance ;
3. mettre en place et en œuvre un programme de renforcement des capacités des communautés locales dans la gestion de la concession forestière.

Article 75.-

L'administration centrale chargée des forêts est tenue d'élaborer et de publier :

1. le guide opérationnel d'élaboration du plan simple de gestion prévu au chapitre III ci-dessus ;
2. le modèle des contrats d'exploitation et/ou de gestion prévus aux articles 36, 37, 45, 51 et 66 ci-dessus ;
3. le guide opérationnel d'application de la cartographie participative ;
4. le modèle de permis de coupe communautaire prévu à l'article 41 ci-dessus ;
5. tout autre outil relatif à la gestion et à l'exploitation de la concession forestière.

Aux fins des dispositions de l'alinéa 1er ci-dessus, l'administration centrale chargée des forêts veille à l'implication de toutes les parties prenantes de la foresterie communautaire.

Article 76.-

L'administration provinciale chargée des forêts assure le relai de l'administration centrale pour la mise en œuvre effective des stratégies de foresterie communautaire et l'application des méthodes et pratiques de gouvernance forestière sur le terrain.

Elle dresse à l'attention de l'administration centrale des rapports trimestriels relatifs à la gestion et à l'exploitation des concessions forestières de son ressort.

Article 77.-

Le service forestier du secteur, de la chefferie ou de la commune urbano-rurale, selon le cas, assure le suivi régulier de la gestion et de l'exploitation des concessions forestières de son ressort.

Il assiste techniquement les communautés locales titulaires de concessions forestières, notamment dans la mise en place des modalités de gestion desdites concessions, la fixation des limites de celles-ci, et l'élaboration du plan simple de gestion y afférent.

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Section 2 : Contrôle forestier

Article 78.-

La communauté locale, à travers son comité local de contrôle et de suivi-évaluation ou son entité distincte de gestion prévus au chapitre II ci-dessus, participe activement au contrôle de la gestion de sa concession.

A cette fin, elle collabore avec le service de contrôle forestier compétent en mettant à profit les connaissances et les pratiques traditionnelles positives de la communauté.

Article 79.-

Le contrôle forestier porte notamment sur les éléments suivants :

1. la conformité de l'exécution du plan simple de gestion de la concession forestière avec les dispositions du présent arrêté ;
2. le respect des règles de gestion de la concession forestière ;
3. le respect de la réglementation en vigueur régissant l'exploitation de la concession forestière, y compris les dispositions du présent arrêté, notamment : la coupe de bois d'œuvre, la récolte des produits forestiers non ligneux, l'exploitation des bois d'énergie, l'exploitation des produits de la chasse et de la pêche, la conservation de la biodiversité et le paiement des services environnementaux, la pratique de l'écotourisme et de la bio prospection ;
4. Le respect des dispositions relatives à la reconstitution du capital forestier de la concession forestière.

Article 80.-

Sous peine de sanctions pénales et du retrait de toute autorisation d'exploitation, la communauté locale est tenue, à travers son comité local de gestion ou son entité distincte de gestion, de laisser l'administration chargée des forêts assurer ses missions de supervision technique et de contrôle forestier.

CHAPITRE X : DES DISPOSITIONS RELATIVES AUX SANCTIONS

Article 81.-

Toute violation du présent arrêté est punie conformément aux dispositions du code forestier, particulièrement celles des articles 143, 144, 145, 147, 148, 149, 153 et 154, et à toute autre disposition légale en vigueur.

Article 82.-

La gravité des faits incriminés en vertu de l'article 81 ci-dessus peut donner lieu à la suspension :

1. soit de l'ensemble des contrats d'exploitation de la concession forestière par le gouverneur de province après avis de l'administration provinciale en charge des forêts du ressort ;

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2. soit d'un contrat relatif à l'exploitation d'une activité par le chef de secteur, le chef de chefferie ou le bourgmestre urbano-rural du ressort, après avis du service local des forêts.

La suspension est accompagnée du retrait de toute autorisation d'exercice de l'activité concernée.

Article 83.-

Le chef de la communauté locale concernée veille à l'application des dispositions légales et réglementaires en vigueur, y compris en particulier celles du présent arrêté.

A cette fin, il est tenu de dénoncer auprès de l'administration locale des forêts toute violation des susdites dispositions perpétrée au sein de la communauté locale.

En cas d'infraction ayant causé un préjudice grave à l'écosystème forestier de la concession forestière ou à la communauté locale, il en est tenu pour civilement responsable sauf s'il prouve qu'il n'a pas eu connaissance de la commission de ladite infraction.

CHAPITRE IX : DES DISPOSITIONS FINALES

Article 84.-

Sont abrogées toutes les dispositions antérieures contraires au présent arrêté.

Article 85.-

Le Secrétaire Général à l'Environnement, Conservation de la Nature et Développement Durable est chargé de l'exécution du présent arrêté qui entre en vigueur à la date de sa signature.

Fait à Kinshasa, le 09 FEV 2016

Robert BOPOLO MBONGEZA

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ANNEX G: WRI REPORT FOR DRC ASSESSMENT

Analysis of Geospatial Data to Inform the USAID ProLand Assessment of opportunities to improve agricultural land use and reduce GHG emissions in the Democratic Republic of Congo (DRC)

1.0 BACKGROUND

Proland has been asked by USAID to carry out a strategic assessment of the best ways to support sustainable agricultural intensification in DRC so as to reduce GHG emissions from land use change associated with the expansion of agricultural land use. As the lead implementer of ProLand, Tetra Tech has requested WRI to provide a number of mapping products and deliverables, including maps of tree cover gain and loss, carbon density, and carbon emission hotspots. This report provides a description of the methods used, summarizes the results and provides a brief narrative on data quality, strengths and weaknesses of various approaches, and proximate drivers of forest loss within DRC.

2.0 METHODS

2.1 Description of Datasets Used

Tree Cover Loss and Gain

The global tree cover loss and gain data for the years 2001-2012 at 30 m resolution were first published by Hansen et al. (2013) using data from the Landsat 7 satellite and processed in Google Earth Engine. Annual updates for 2013 and 2014 are available on the Global Forest Watch website, and results for the year 2015 are expected in July 2016. The data capture trees taller than 5-m in height. The annual loss product represents stand replacement disturbance, i.e. a disturbance that results in a pronounced drop in canopy cover. Forest degradation activities that do not result in such a pronounced drop in canopy cover, such as harvesting wood for charcoal around cities in DRC, are less likely to be detected by the UMD loss product, and developing mapping products that can capture these more subtle changes to the forest canopy is currently an active area of remote sensing research. The Hansen et al. (2013) gain product is not annual; it reflects lands that have experienced a transition from a non-forest to forest state at any time between 2000 and 2012, a definition that omits regrowing forests that have not reached 5 m in height by 2012. In DRC, a single pixel can appear in both the loss product as well as the gain product if it was lost early enough in the time series to also exhibit enough regrowth by 2012 to show up in the gain product.

Data from the new Landsat 8 sensor became available starting in 2013, and an updated Hansen et al. tree cover loss algorithm was applied starting with the 2014 annual loss product. The incorporation of Landsat 8 data led to improved detection of loss in boreal forests, smallholder agricultural clearing, selective logging, and short cycle plantation clearing. The entire loss time series (2001-2014) is in the process of being updated using the new algorithm (release date not yet available). In the meantime, a moving window has been applied whereby with each new year of loss data, the previous two years are also updated to reflect the new algorithm.

Aboveground Live Biomass Density

There is currently no way to measure forest biomass, forest carbon, or forest carbon loss/gain directly from space. Because it is infeasible to measure forest carbon at every point on the landscape, traditional methods involve a statistical ground sampling approach, where field inventory plots are distributed across a landscape and forest structural variables (such as tree diameter and height) are measured by field technicians at each

plot. Tree diameter and height are used in allometric models to estimate forest biomass. After all plots are analyzed, the result is a statistically valid estimate of the average biomass carbon stored in trees across the area of interest, with an associated estimate of uncertainty derived from standard error analysis. Sometimes the landscape is subdivided into strata to improve sampling efficiency, with separate statistics derived for each stratum.

Field sampling is labor intensive, time consuming and often prohibitive in remote areas where access is limited. Therefore to generate landscape to biome-scale estimates of forest carbon, some studies simply extrapolate any available plot-based biomass estimates to the total forest area thought to be represented by the plots, assuming (often incorrectly) that measured plots represent an unbiased sample of the landscape (Marvin , Asner, and Knapp, 2014).

Several recent studies (e.g., Baccini, Goetz, and Walker, 2012, Saatchi et al., 2011) have demonstrated the utility of supplementing ground measurements of forest carbon with other remote sensing data products to create wall to wall maps of forest carbon at varying spatial resolutions. Forest carbon stored in trees has been estimated in numerous studies using a variety of remotely sensed data, including high, medium, and coarse resolution passive satellite data (such as QUICKBIRD, Landsat, and MODIS, respectively), as well as data from active sensors, such as LiDAR (Light Detection and Ranging) and SAR (Synthetic Aperture Radar) (Goetz et al., 2009). Techniques for imagery interpretation and modeling the relationship between ground-measured carbon and remote sensing metrics vary across studies.

The aboveground live woody biomass density dataset used in this analysis expands upon methods presented in Baccini, Goetz, and Walker (2012) to create a 30-m resolution map of tropical aboveground live biomass density, available for download and visualization on the Global Forest Watch Climate website. Ground-based measurements of forest biomass density (in tons of biomass stored per hectare) were co-located with LiDAR waveform metrics to estimate the biomass density of more than 40,000 LiDAR footprints throughout the tropics. The estimates were then correlated to continuous, gridded variables, including Landsat 7 ETM+ satellite imagery, elevation, and biophysical variables to create a wall-to-wall 30-m resolution map of aboveground woody biomass density across the tropics.

Carbon Emissions from Tree Cover Loss

By co-locating the two maps of aboveground live biomass density (t/ha) and the area of tree cover loss (ha), it becomes possible to estimate the magnitude and spatial distribution of biomass loss resulting from tree cover loss using a consistent method. This 30-m resolution map product is available for download and visualization on the Global Forest Watch Climate website and described further in Zarin et al. (2016). Estimates are based on the co-location of aboveground live woody biomass density values for the year 2000 with annual tree cover loss data from 2001 through 2014 from Hansen et al. (2013), both at 30 meter spatial resolution. Carbon emissions from biomass loss per pixel were calculated using a biomass to carbon conversion factor of 0.5 and a carbon to CO_2 conversion factor of 3.67. It is assumed that the entire area represented by a pixel was completely cleared and all biomass was removed; all loss of aboveground biomass is considered to be "committed" emissions to the atmosphere upon clearing, although there are lag times associated with some aboveground carbon pools. Emissions are "gross" estimates rather than "net" estimates, meaning that information about the fate of land after clearing, and its associated carbon value, is not incorporated due to a current lack of reliable data. Emissions associated with other carbon pools, such as belowground biomass, soil carbon and harvested wood products, are excluded from the dataset.

It was not possible to develop a similar map of carbon sequestration resulting from forest gain by combining the aboveground live biomass density map with the forest gain product. A key assumption of the biomass loss dataset is that upon clearing, all carbon stored in aboveground tree biomass is emitted to the atmosphere as carbon dioxide. Rates of carbon sequestration in re-growing forests are variable, and the Hansen et al. (2013) gain product does not provide information about when forest was gained during the time series. Furthermore, both new and old forests sequester carbon dioxide at rates that are highly dependent upon both

biophysical factors such as temperature, precipitation and soil type, as well as other factors such as prior disturbance history.

2.2 Hotspot Analysis

In addition to producing maps showing locations of tree cover loss and carbon emissions in DRC, we also performed a carbon emissions hotspot analysis for the time period 2011-2014, i.e. the last 4 years in the time series. For this analysis, forests were defined as areas with tree canopy density greater than 30% in the year 2000. We also removed grassland areas from the analysis. Grasslands were defined as all land cover classes included in Table 1, based on the Africover land cover dataset.

Table 1: Land Cover Classes Representing Grasslands from Africover Dataset

Grassland	Closed (>65%) tall (0,8-3 m) herbaceous vegetation with sparse (4-15%) medium trees (7-14 m).
Aquatic Grassland	Closed (>65%) tall (0,8-3m) herbaceous vegetation on permanently (> 4 months) or temporarily (2-4 months) flooded land.
Swamp Grassland	Closed (>65%) tall (0,8-3 m) herbaceous vegetation on waterlogged soil.
Sparse Vegetation	Sparse (<15%) trees, sparse (<15%) shrubs, herbaceous sparse (<15%) vegetation.
Mosaic Cultivated Areas/Vegetation	Cultivated and managed terrestrial area(s) (cropland-rainfed trees) and/or closed to open (40-100%) shrubland (Thicket) and/or herbaceous closed to open (40-100%) vegetation.

In contrast to the raw carbon emissions 30-m data (described above), the hot spot analysis was designed to indicate broad locations within DRC that represent statistically significant clusters of high carbon emissions. Carbon emissions data at the 30-m pixel resolution were aggregated into larger 5 km grids, and a hot spot analysis was run to determine places where observed patterns in carbon emissions are not the result of random processes or subjective cartographic design decisions; they represent places where there are underlying, non-random spatial processes at work. Hot spot analysis works as a moving window, where each location is compared to its surrounding neighborhood. Increasingly saturated red and blue colors on the maps represent increasingly high confidence that the clustering is non-random. Therefore, a hot spot with a 99% confidence interval (darkest red) means there is a 1% chance that a cluster of high carbon emission values is due to random chance. Likewise, a cold spot with a 99% confidence interval means there is a 1% chance that the cluster of low carbon emissions values is due to random chance. It is important to note that hot spots are not defined solely on the basis of where individual pixels with high carbon emission values are located; it is designed to find *clusters* of high values. As a result, locations of resulting hot spots may not necessarily be the same as where carbon emissions are highest within individual pixels on the map.

3.0 RESULTS

Maps of tree cover loss, tree cover gain, forest biomass density across DRC and within CARPE priority landscapes are provided in Annex 1. Hot spot results indicate that there are clusters of statistically significant high carbon emissions around cities and transportation corridors. Hot spots can be seen around cities, such as Bafwasende, Djolu, Basankusu, and Boende, among others. Hot spots also follow some road networks in DRC, specifically the road between Lubutu and Walikale in the eastern part of the country, and between Makanza and Basoko in the northern part of the country.

CARPE Priority Landscape maps provide insight into locations of tree cover loss and associated carbon emissions at a regional scale. In all of the CARPE landscapes, carbon emissions tend to occur along forest access networks, e.g. major roads and rivers. One exception is in the Ituri-Epulu Aru Landscape, which shows areas of fragmented loss between two major roads in the eastern part of the landscape. Carbon emissions generally occur outside of most protected areas of these landscapes, with the exception of the

Virunga Landscape, which had high emissions near Beni and Rwindi in the northern and southern parts of the park, respectively.

4.0 DISCUSSION

4.1 Data Quality

The quality of remotely sensed datasets is often assessed by performing accuracy assessments, where classified values (e.g., loss/no loss) are compared to a sample of "truth" data collected either on the ground or from imagery with higher spatial resolution. Below we discuss the accuracy of the data products used in this analysis.

Tree Cover Loss and Gain

The tree cover loss dataset was independently validated and found to have an overall accuracy of 99.6% globally (Hansen et al.., 2013). Annual allocation of change was also validated and found to match for 75.2% of forest loss events. 96.7% of loss events occurred within one year before or after the estimated year of disturbance.

However, based on samples from multi temporal Landsat and high resolution imagery, Tyukavina et al. (2015) calculated that Hansen et al. (2013) underestimated tree cover loss in DRC by 65% for the time period of 2000 to 2012, with missed loss located closely around detected loss. The updated loss detection method applied for the years 2011-2014 has not yet been fully validated. A validation study is planned and may find a more sensitive method for detecting forest disturbance with the newly incorporated Landsat 8 data.

Aboveground Live Biomass Density

An independent accuracy assessment on the aboveground biomass density layer is not available, and is unlikely to be available due to the time and cost associated with collecting field data for validation. However, data quality can instead be assessed by calculating error as the difference between the true mean biomass value (ground and lidar-estimated AGB) and the predicted biomass value (mapped at 30-m grid cell resolution) and propagating these errors through the spatial modeling process. The result is a related uncertainty layer that goes along with the 30-m biomass layer, where the value of each pixel in the uncertainty map represents the error associated with the assigned biomass value in the pixel. Using both layers together (mean and uncertainty) allows an estimation of the error associated with biomass in DRC's forests. According to the Woods Hole 30 m data, DRC's forests contain an average of 138 Mg/ha of aboveground biomass per hectare. The uncertainty layer has not yet been processed for the Woods Hole dataset, but this estimate of mean biomass is very close to an independent estimate from Saatchi et al. (2011), who estimate biomass density in DRC as 134 Mg C/ha, with a low estimate of 120 and a high estimate of 144 Mg C/ha.

Carbon Emissions from Tree Cover Loss

Tyukavina et al. (2015) used a similar approach to mapping forest biomass and biomass loss in DRC as calculated in this analysis, but estimates were developed for different forest classes (strata) rather than for specific 30 m pixels. When adjusted tree cover loss estimates were used (accounting for underestimation of loss as reported by Hansen et al. 2013, described above), gross carbon loss within DRC was 86 ± 19 Tg C yr-1 between 2000-2012, with 46 ± 12 Tg C yr^{-1} occurring within natural forests. Using unadjusted tree cover loss data from the original Hansen et al. (2013) dataset and the 30 m biomass map yields gross carbon loss estimates in DRC of 51 Tg C yr^{-1} between 2000-2012.

4.2 Incorporation of Landsat 8 data

Figure 1 shows Hansen et al.'s annual tree cover loss data in DRC, with pink bars indicating loss estimates from the original Hansen et al. (2013) product, and the blue bars indicating the additional loss assigned to 2012 and 2013 when 2014 data were released. In other words, the blue portions of the 2012 and 2013 bars indicate the additional loss resulting from using the updated algorithm. While the different algorithms may

have some impact on the results for later years, it is also clear from Figure 1 that the uptick in tree cover loss between 2011 and 2014 is likely to be real and not solely an artifact of the new sensor.

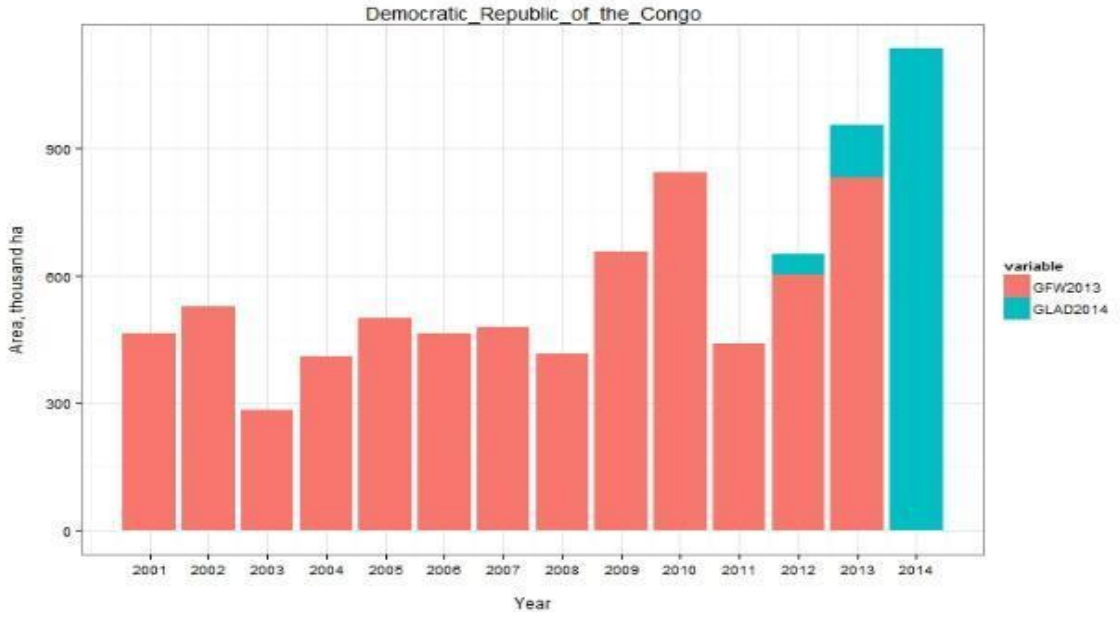

Figure 1. Area of annual tree cover loss in the Democratic Republic of the Congo as estimated in the original Hansen et al. (2013) forest change product (pink) and the additional loss estimated for years 2012 and 2013 as a result of applying an improved loss algorithm in year 2014 that is more sensitive to small-scale forest changes (blue).

4.3 Strengths and Weaknesses of Data Products

The aboveground biomass and tree cover loss data both provide consistent, pantropical coverage of forest biomass and tree cover loss, respectively. Both datasets are available at medium (30 m) resolution, and when used together to calculate carbon emissions, provide consistent and comparable values that can be used for monitoring programs. As shown by Tyukavina et al. (2015), the original Hansen et al. (2013) dataset significantly underestimated tree cover loss within DRC for the period of 2001-2012; tree cover loss observed in 2013 and 2014 in DRC is higher, due in part to the increased sensitivity of the Landsat 8 sensor for detecting change in this region.

While the datasets are groundbreaking, the data do not explain the reasons for observed tree cover loss and therefore loss of tree cover cannot technically be described as deforestation (i.e., conversion of forest to a permanent, non-forest use). Tree cover loss, and therefore carbon emissions from tree cover loss, may occur for a variety of reasons, including deforestation, fire, shifting cultivation cycles, or logging. The tree cover loss data can only detect that stand replacement disturbance occurred, but not the reasons behind the occurrence. The tree cover loss data also contains some temporal inconsistencies due to improved loss detection methods for years since 2013.

4.4 Forest Dynamics in DRC

Although Hansen et al. provide separate products for gross forest loss and gross forest gain, they do not advise combining these loss and gain products to calculate net change. Estimating forest regrowth over relatively short intervals is much more challenging than estimating stand-replacement forest loss, due to the continuous and bioclimatically varying nature of forest growth compared to the abrupt nature of forest loss. Likewise, the loss and gain products cannot be combined with estimates of carbon density to calculate net

carbon change. The Hansen team believes that a longer record of satellite observations (>20 years) is needed for quantifying net area change dynamics, and the extension of the pantropical Landsat inputs pre-2000 and post-2012 to achieve such a record of net forest change is a current focus of their research.

Shifting cultivation mosaics are a prevalent, long-established land use in DRC (Mayaux et al., 2004; DeWasseige et al., 2012; Potapov et al., 2012). After the initial cycle of forest clearing, cultivation, and forest regrowth (to secondary forest), subsequent cycles often include regrowth intervals that are long enough to recover pre-clearing quantities of secondary forest aboveground biomass (Zarin et al., 2016). This is evident in the loss and gain maps for DRC, where the same forest areas can show up as lost and gained over the 2001-2014 time period. The result is a "rural complex", a characteristic land cover mosaic of roads, villages, active and fallow fields and secondary forest. Forest clearing has varying impacts depending on where it occurs relative to this area: whether inside it, along its primary forest interface, or in more isolated primary forest areas. From a carbon perspective, stable shifting cultivation mosaics are similar to tree plantations for area-based carbon accounting, insofar as only the initial clearing of natural forest should be counted as gross deforestation. The expansion of the rural complex can degrade the forest through forest fragmentation, resulting in formerly intact forest ecosystems being impacted by edge effects created by clearings (Molinario, Hansen, and Potapov, 2015). This is a drastically different land use dynamic than the large-scale clearings observed in Brazil and Indonesia; the context of where tree cover loss is occurring within DRC is as important as the per-pixel detection itself in correctly quantifying the impact that clearing has, as relatively small areas of clearing can have large impacts on the environment. Molinario, Hansen, and Potapov (2015) investigated this crucial missing element in forest cover loss in the DRC by quantifying the spatio-temporal context in which it occurs. Specifically, they mapped the expansion of the rural complex in DRC between 2000 and 2010 and showed that it grew by 10.2% between 2000 and 2010, adding 46,182 ha of rural complex to the country. Potapov et al. (2012) and Molinario, Hansen, and Potapov (2015) both show that most loss (86.4%) occurs within the mosaic of secondary succession in the rural complex. This clearing occurs by either reusing secondary forest and fallows or clearing patch and edge forest.

4.5 Identifying Proximate Drivers of Tree Cover Loss in DRC

The major driver of deforestation in DRC in recent history has been the expansion of subsistence activities (agriculture and energy) concentrated around areas with high population density (Hourticq and Megevand, 2013). Deforestation in DRC, as elsewhere, rarely has only one direct cause: there is a strong interplay between logging, agriculture, fuel wood, and bush fires. Small scale slash-and-burn agriculture and exploitation of wood for fuel (including charcoal) and timber appear to be the major drivers of loss and degradation in the country.

United Nations Environment Program (UNEP) identifies, in order of importance, the following drivers of deforestation in DRC (2011):

1. Slash and burn agriculture with short fallow periods;
2. The collection of wood energy, which covers 95% of household energy needs;
3. Illegal, selective logging, representing 75% of timber exports;
4. The creation and improvement of road infrastructure, which opens all forest areas to human activity.

Factors that are likely to influence the future of deforestation in DRC include improvements to agricultural productivity and infrastructure, as well as acceleration of industrial logging and mining (Hourticq and Megevand, 2013). DRC has enormous expanses of uncultivated land, unconstrained water resources, and a rapidly urbanizing population, which are all factors that are likely to lead to increased agricultural productivity (Hourticq and Megevand, 2013). Agriculture improvements help to feed a food-insecure population and can increase the value of land, which puts pressure on forests. Road construction, which is needed to bring crops to market, can remove previous natural barriers to development in forested areas (Ickowitz et al., 2015; Hourticq and Megevand, 2013).

Drivers of deforestation in DRC are not always easy to quantify and distinguish due to the limited availability of data. Some land uses are extremely difficult to distinguish from shifting cultivation using remote sensing alone, for example the extraction of wood fuel and charcoal production, which are thought to contribute significantly to forest degradation especially in peri-urban areas (DeWasseige et al., 2012). Public and logging roads data are available through the Open Street Map Logging Roads initiative, which captures presence of roads in DRC and certain metadata, such as road condition and age, through crowdsourcing. However, these data need to be validated and further work is needed to produce a complete dataset. Some studies have also attempted to locate and understand shifting agricultural areas in DRC (Nackoney et al*.,* 2013; Molinario, Hansen, and Potapov, 2015). However, more work is needed to understand the connection between population density, migration, and its effects on forest degradation. Finally, selective logging is difficult to detect in DRC. While the tree cover loss dataset has improved the ability to quantify annual loss in the country, it is not able to reliably capture forest degradation. In summary, mapping the spatial footprint of forest disturbances requires additional steps beyond the acquisition of remote sensing observations.

4.6 Linking Loss and Access

DRC is the second largest country in Africa, and home to the largest contiguous expanse of tropical forest in the world, after Brazil. In 2000, DRC supported nearly 200 million hectares of tree cover, canvassing about 87% of the country's land area (Hansen et al., 2013). From 2001 to 2014 DRC lost nearly 8 million hectares of tree cover (Hansen et al*.,* 2013). The highest amount of tree cover loss was observed in 2014, with the country losing 1.1 million hectares of tree cover in a single year.

Proximity to roads and increased access has been linked to increased levels of tree cover loss in DRC (Li *et al.,* 2014). Recently, the government of DRC has invested in transportation infrastructure, including 8,500 km of road pavement and the construction and improvement of railways, with projects totaling 8.5 billion USD during 2010-2016 (Li, De Pinto, and Ulimwengu, 2014). Many of these transportation rehabilitation projects are close to DRC's forests and significantly affect the profitability of logging and agricultural activities.

Building roads and improving access to rural areas is considered an important part of development and poverty alleviation; however, studies conclude that increased accessibility to forests increases the pressure for deforestation in DRC (Li, De Pinto, and Ulimwengu, 2014). This trend is also seen in studies from Cameroon (Mertens and Lambin, 1997), the Republic of Congo (Wilkie et al., 2000), the Amazon (Barber et al., 2014; Bax, Francesconi, and Quintero, 2016), and Thailand (Cropper, Puri, and Griffiths, 2001). Improvements in transportation will make DRC more attractive to global investors in oil palm, rubber, timber, and commercial agriculture (Ickowitz et al., 2015). These forces have proven in the rest of the world to dramatically accelerate deforestation (Rudel, 2013).

It should be noted that a few studies suggest that roads are *not* associated with increased levels of deforestation. Andersen (2002) examined deforestation and economic growth in the Brazilian Amazon and concluded that new roads actually reduce the rate of deforestation. That study found that local development occurs around roads and that this draws pressure away from interior forests. Deng et al. (2011) also examined this question in Jiangxi Province, China, and found that roads have no impact on the rate of deforestation.

As a preliminary attempt to more quantitatively assess a correlation between loss and access, we conducted a buffer analysis and calculated the area of tree cover loss occurring between 2011 and 2014 near forest access networks, specifically major roads and navigable water bodies. We examined tree cover loss within 1km distance bands, from 1-10km, away from these access networks. Results indicate that loss decreases with increasing distance from access networks (Figure 2). When comparing total tree cover loss in DRC to these results, we find that 25% of total loss from 2011-2014 occurred within 10km of navigable water bodies and 60% occurred within 10km of major roads.

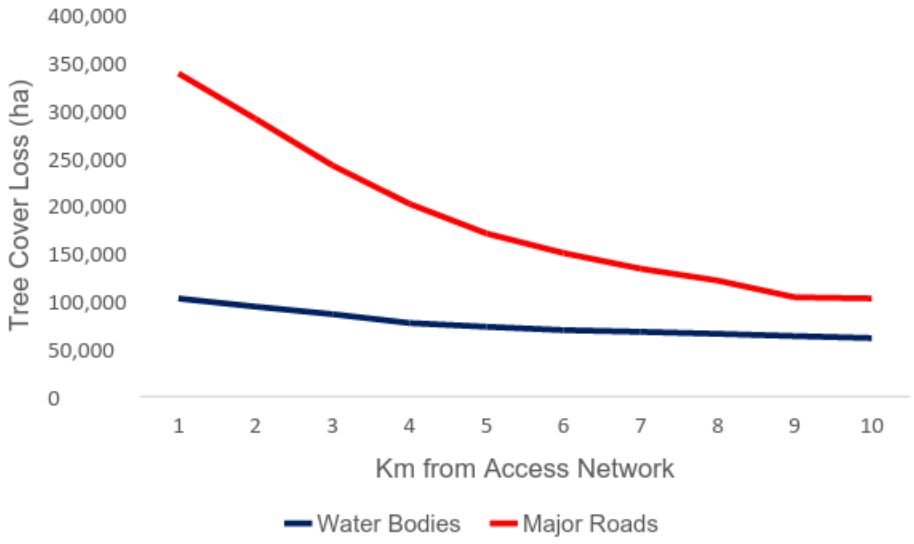

Figure 2: Tree cover loss in 1km bands away from major roads and navigable water bodies.

As part of its Global Forest Watch (GFW) project, the World Resources Institute (WRI) is undertaking work to better understand the link between tree cover loss and accessibility. Using spatial modeling and predictive analysis, WRI is studying how roads, navigable rivers and other means of access can lead to increased levels of tree cover loss. Preliminary results are expected in September of 2016.

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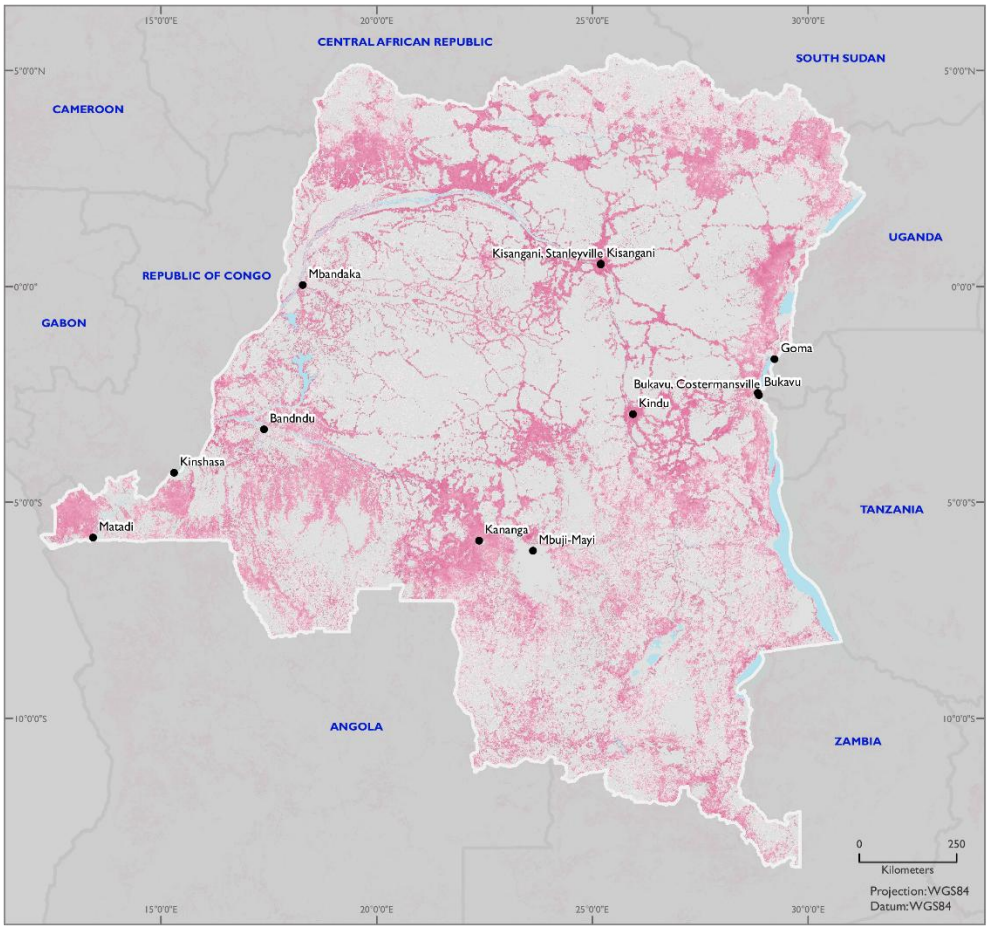
ANNEX 1: SUMMARY OF MAP PRODUCTS

Map 1. Tree Cover Loss in the DRC



Tree cover loss(2000-2014) in the Democratic Republic of the Congo

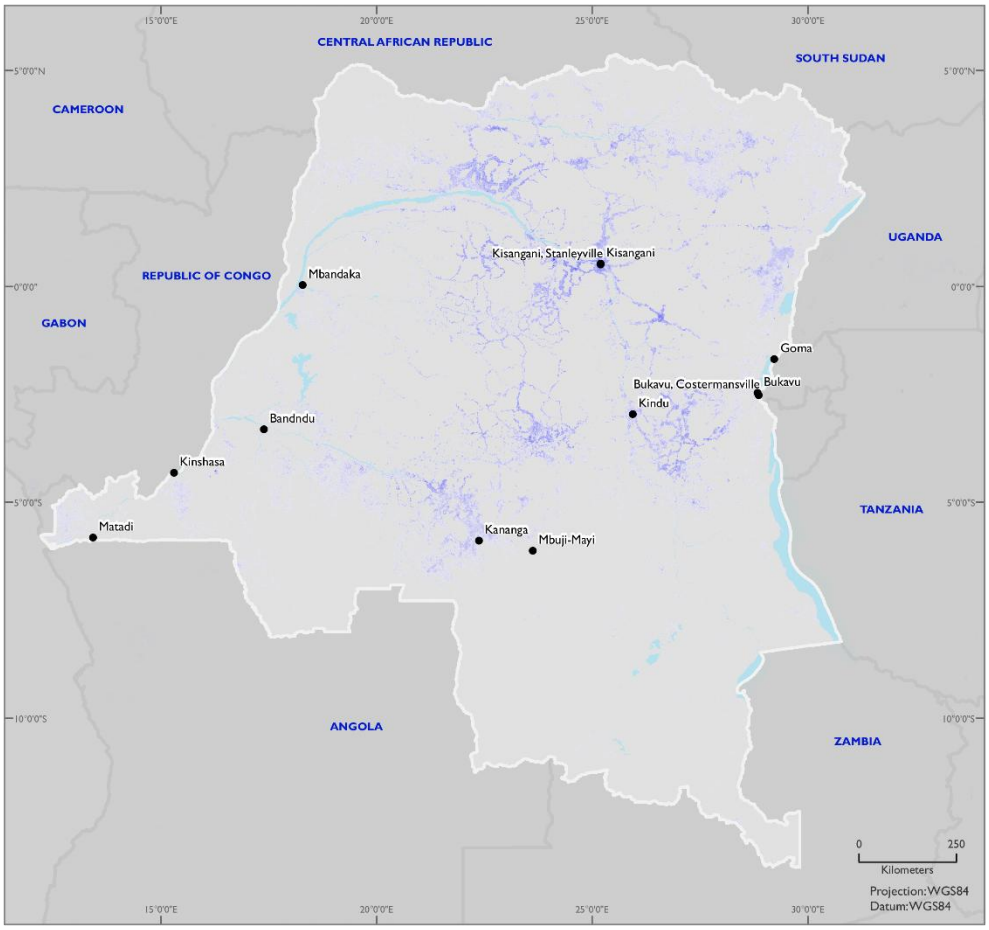
This map shows tree cover loss from 2000 to 2014 among all tree density level in DRC. Tree cover gain/loss dataset, a collaboration between the GLAD (Global Land Analysis & Discovery) lab at the University of Maryland, Google, USGS, and NASA, measures areas of tree cover loss across all global land (except Antarctica and other Arctic islands) at 30 × 30 meter resolution, displayed as a cumulatively yearly layer.

Service Layer Credits: Source: Hansen/UMD/Google/USGS/NASA

- Cities
- Water
- Tree cover loss

Produced for the US Agency for International Development under the Productive Landscapes Project.

Map 2. Tree Cover Gain in the DRC



Tree cover gain(2000-2012) in the Democratic Republic of the Congo

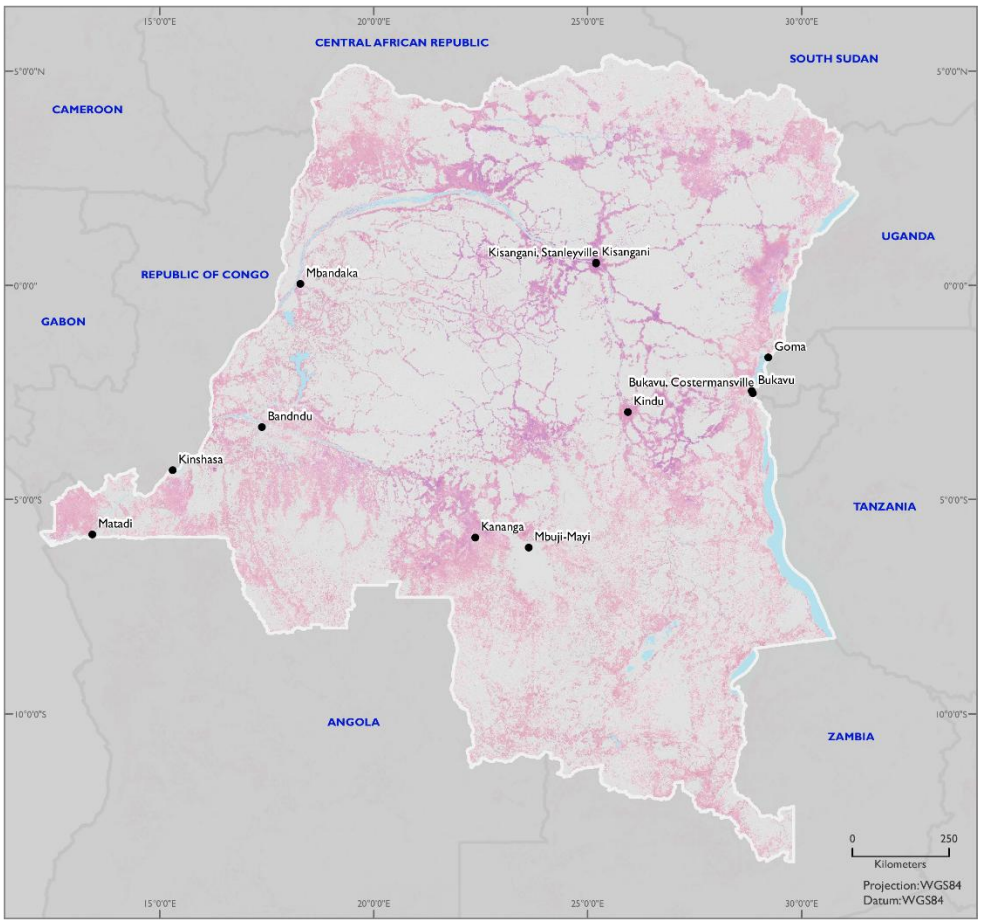
This map shows tree cover gain from 2000 to 2012 among all tree density level in DRC. Tree cover gain dataset, a collaboration between the GLAD (Global Land Analysis & Discovery) lab at the University of Maryland, Google, USGS, and NASA, measures areas of tree cover gain across all global land (except Antarctica and other Arctic islands) at 30 × 30 meter resolution, displayed as a cumulatively yearly layer.

Service Layer Credits: Source: Hansen/UMD/Google/USGS/NASA

- Cities
- Water
- Tree cover gain

Produced for the US Agency for International Development under the Productive Landscapes Project.

Map 3. Tree Cover Loss and Gain in the DRC



Tree cover loss(2000 -2014) and tree cover gain(2000-2012) in the Democratic Republic of the Congo

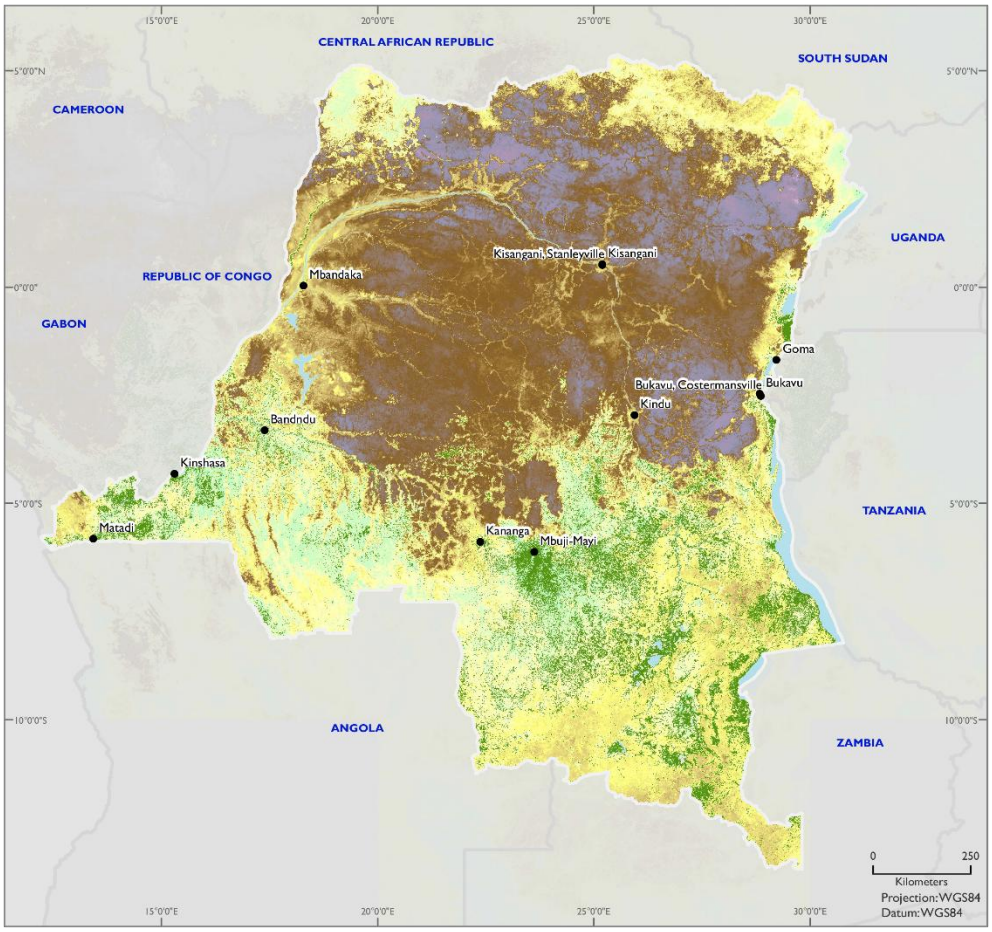
This map shows tree cover loss from 2000 to 2014 and tree cover gain from 2000 to 2012 among all tree density level in DRC. Tree cover gain/loss dataset, a collaboration between the GLAD (Global Land Analysis & Discovery) lab at the University of Maryland, Google, USGS, and NASA, measures areas of tree cover gain/loss across all global land (except Antarctica and other Arctic islands) at 30 × 30 meter resolution, displayed as a cumulatively yearly layer.

Service Layer Credits: Source: Hansen/UMD/Google/USGS/NASA

- Cities
- Water
- Tree cover loss
- Tree cover gain

Produced for the US Agency for International Development under the Productive Landscapes Project.

Map 4. Aboveground Live Woody Biomass Density in the DRC



Aboveground live woody biomass density in the Democratic Republic of the Congo

This map shows aboveground live woody biomass density in DRC. This dataset is a higher resolution data product that expands upon the methodology presented in Baccini et al. (2012) to generate a pan-tropical map of aboveground live woody biomass density at 30 m resolution for circa the year 2000.

Layer source: Baccini A., W. Walker, L. Carvahlo, M. Farina, D. Sulla-Menashe, R. Houghton (2015). Tropical forests are a net carbon source based on new measurements of gain and loss. In review.

- Cities
- Grassland
- Water

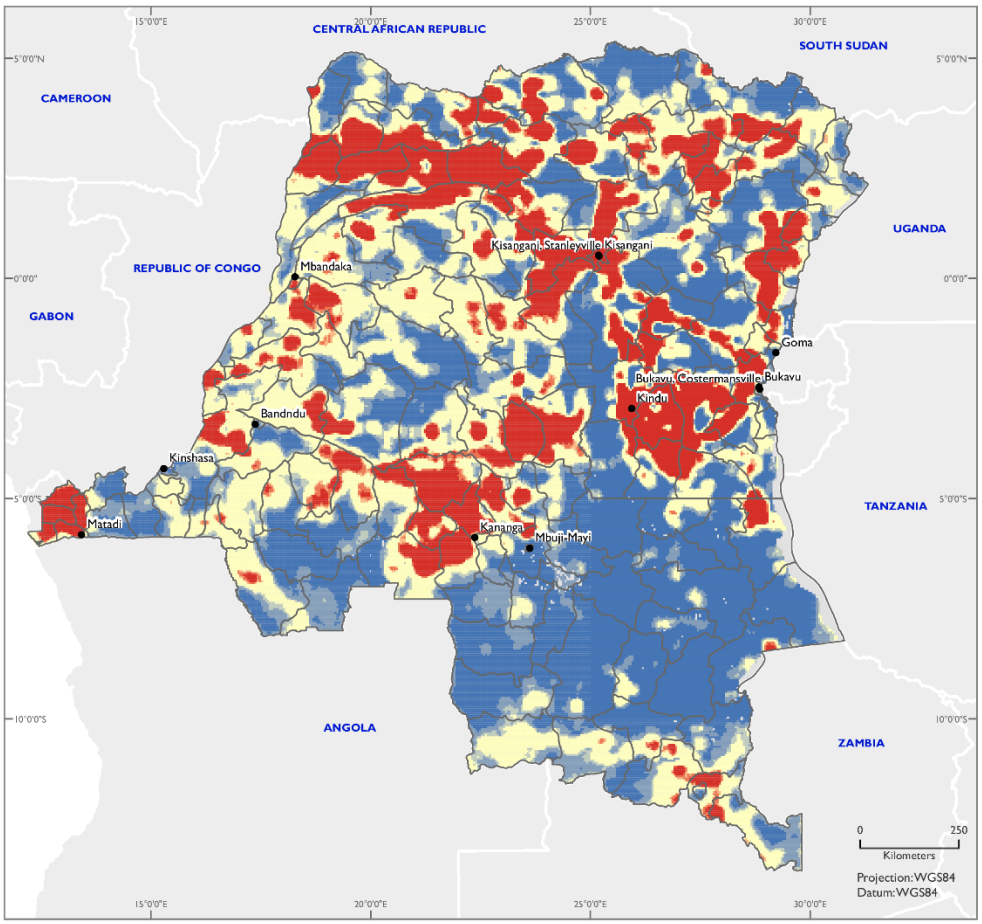
Aboveground live woody biomass Mg/Ha

High : 500

Low : 0

Produced for the US Agency for International Development under the Productive Landscapes Project.

Map 5. Carbon Emission Hotspots for the DRC



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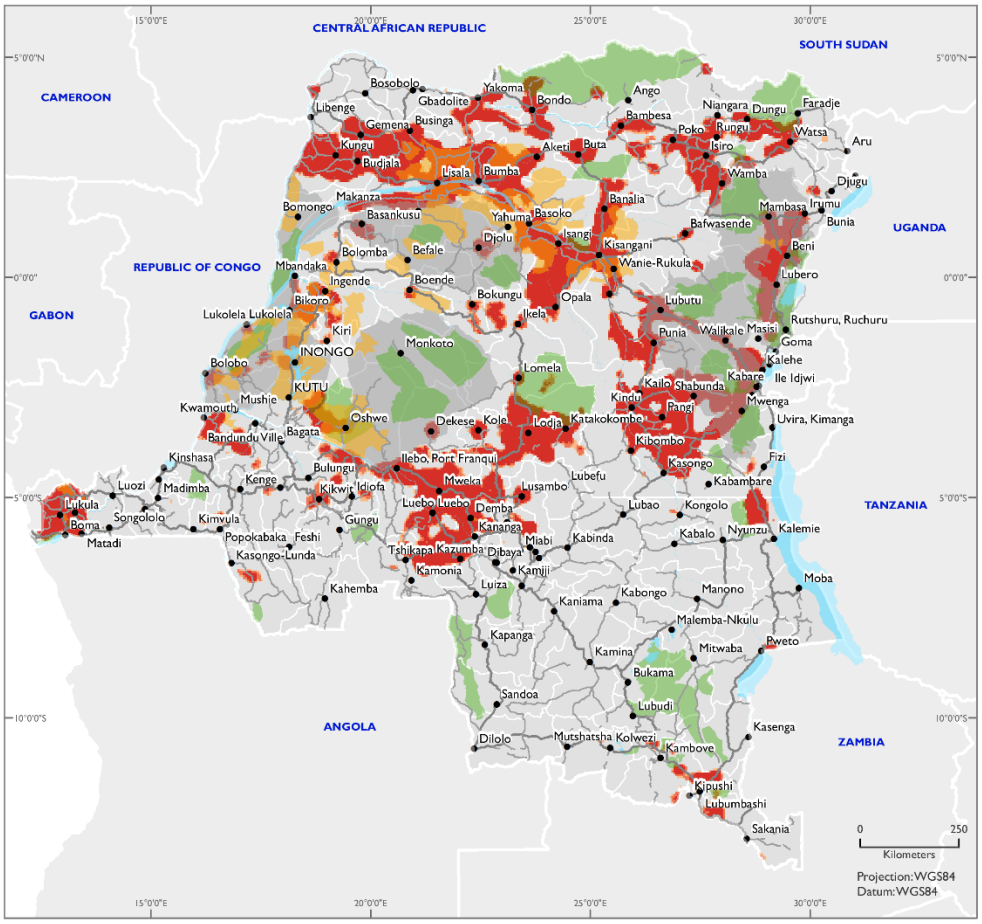
Carbon Emissions Hot Spots for the Democratic Republic of the Congo

This map shows carbon emission hot and cold spots, aggregated to a 5km grid in DRC. Carbon emissions from grassland areas are included in the analysis. Layer calculated using Getis Ord GI* statistic, using a fixed distance band of 20km. Hot spot areas represent statistically significant clusters of high carbon emissions, while cold spot areas represent statistically significant clusters of low carbon emissions.

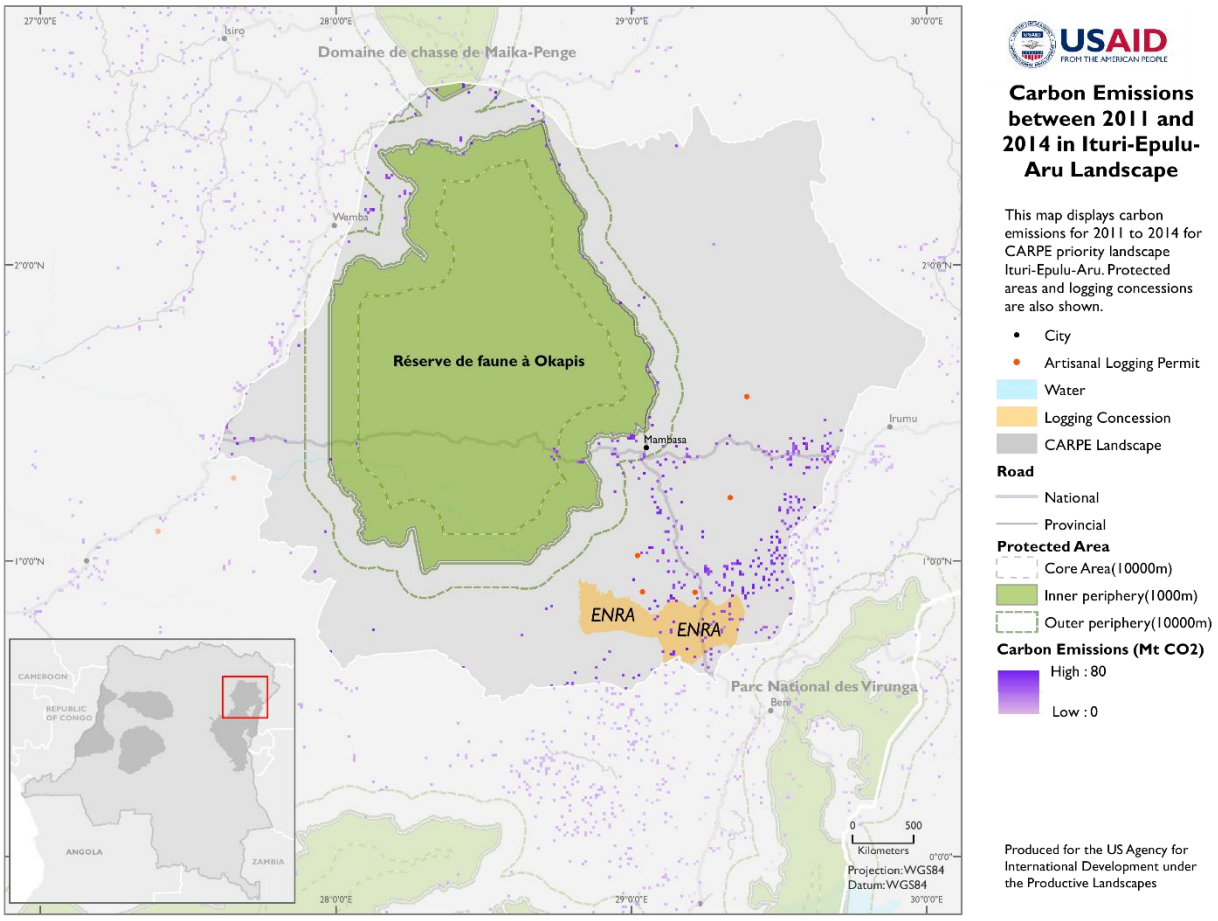
- Cities
- Admin 3 Boundary
- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Statistically Insignificant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Produced for the US Agency for International Development under the Productive Landscapes Project.

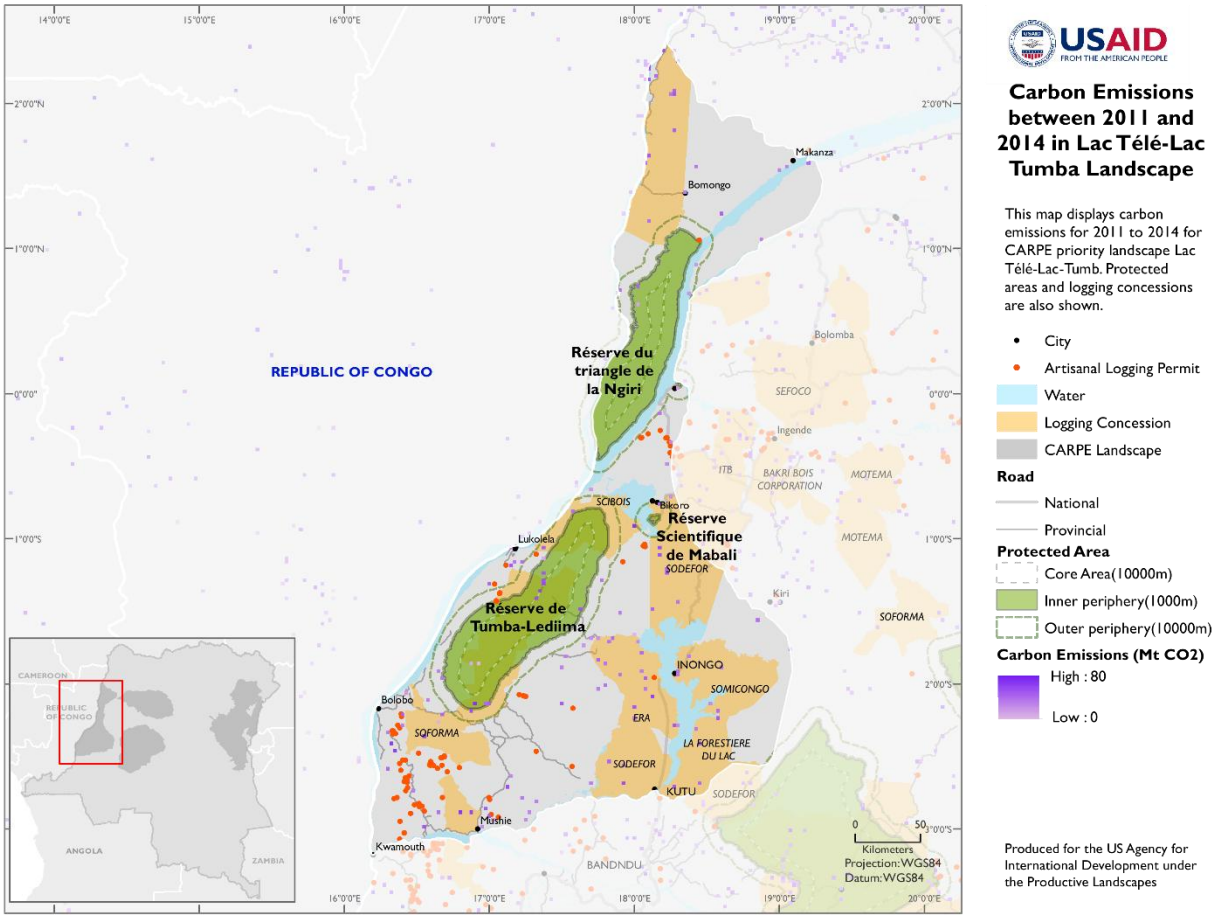
Map 6. Carbon Emission Hotspots for the DRC (Context)



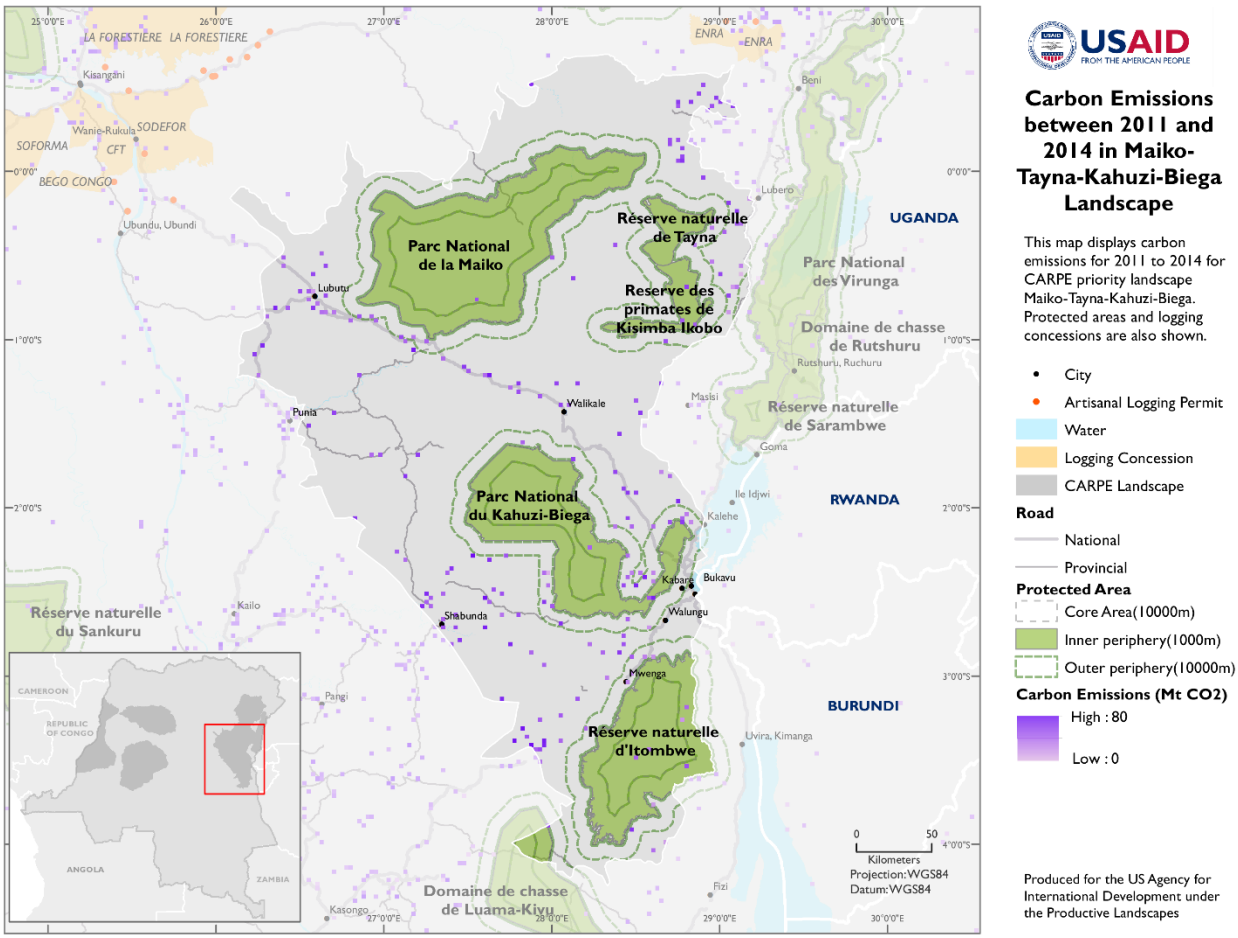
Map 7. Carbon Emissions 2011-2014 in Ituri-Epulu-Aru Landscape



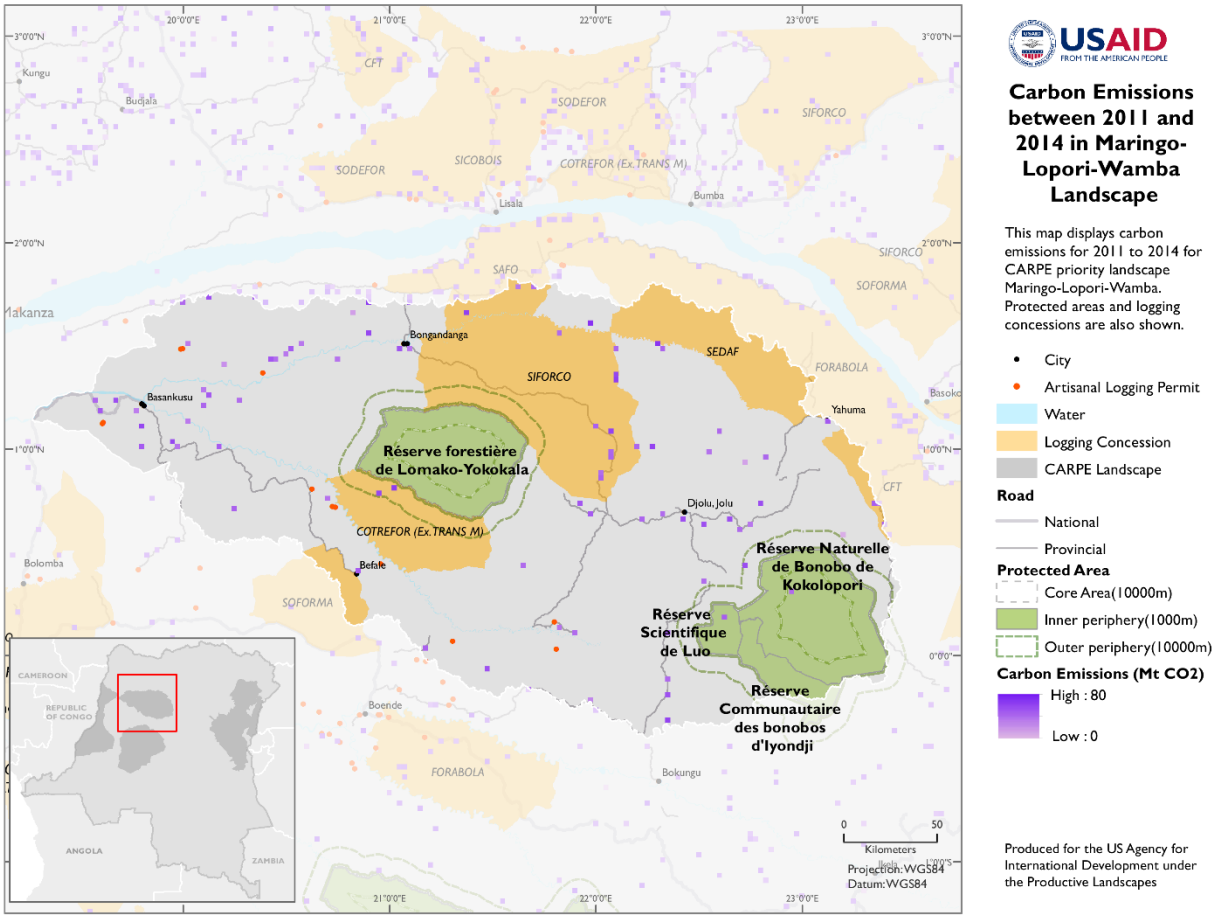
Map 8. Carbon Emissions 2011-2014 in Lac Télé-Lac Tumba Landscape



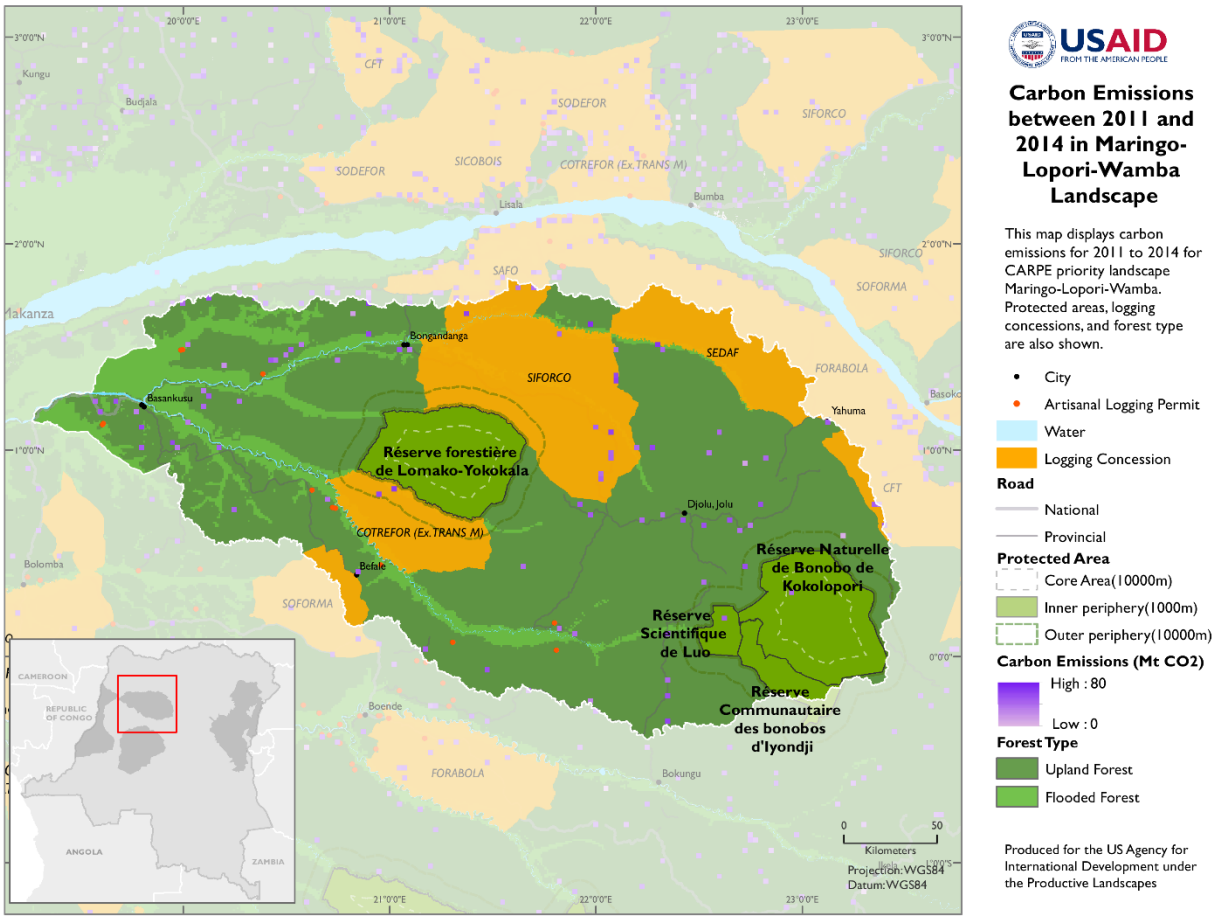
Map 9. Carbon Emissions 2011-2014 in Maiko-Tayna-Kahuzi-Biega Landscape



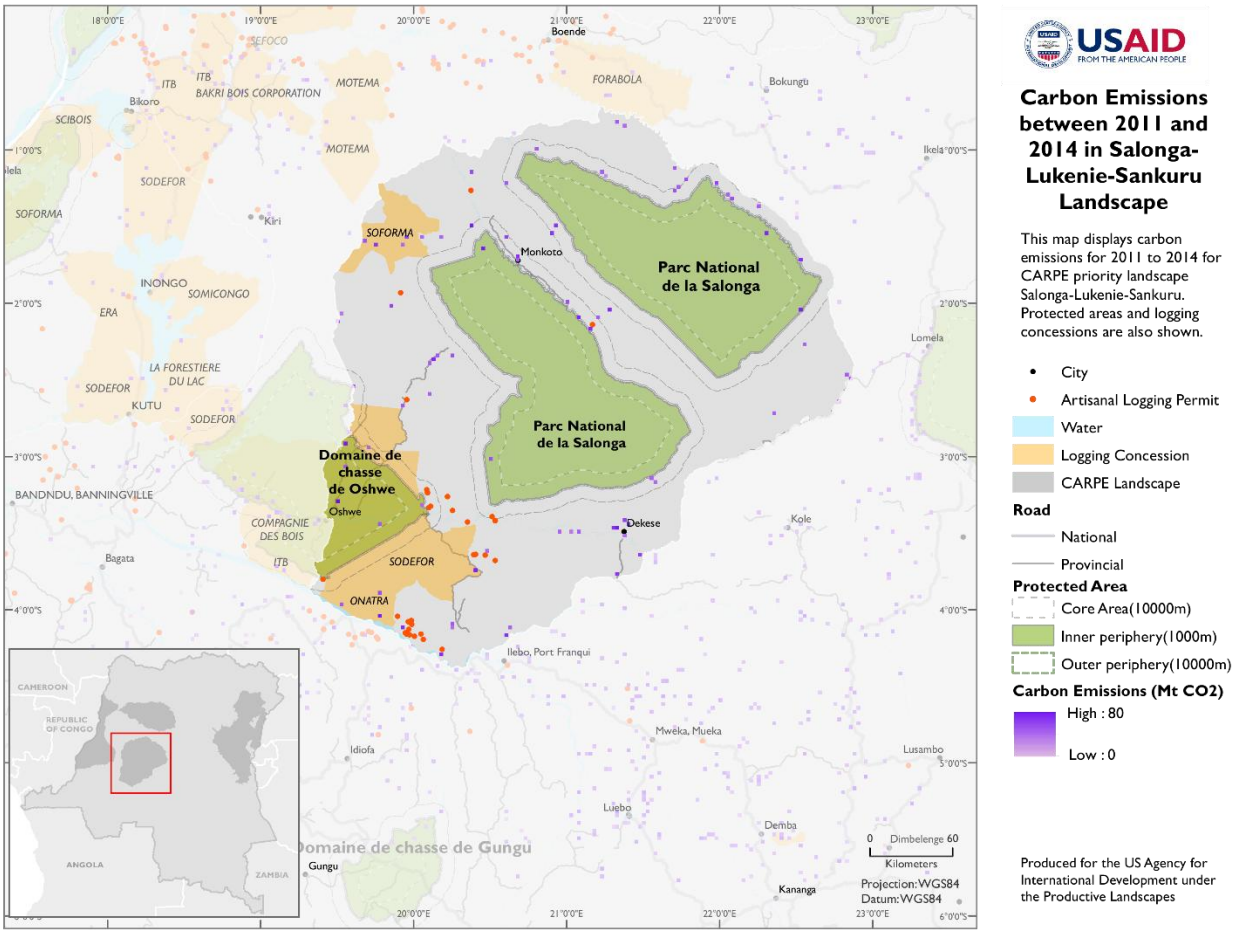
Map 10. Carbon Emissions 2011-2014 in Maringo-Lopori-Wamba Landscape



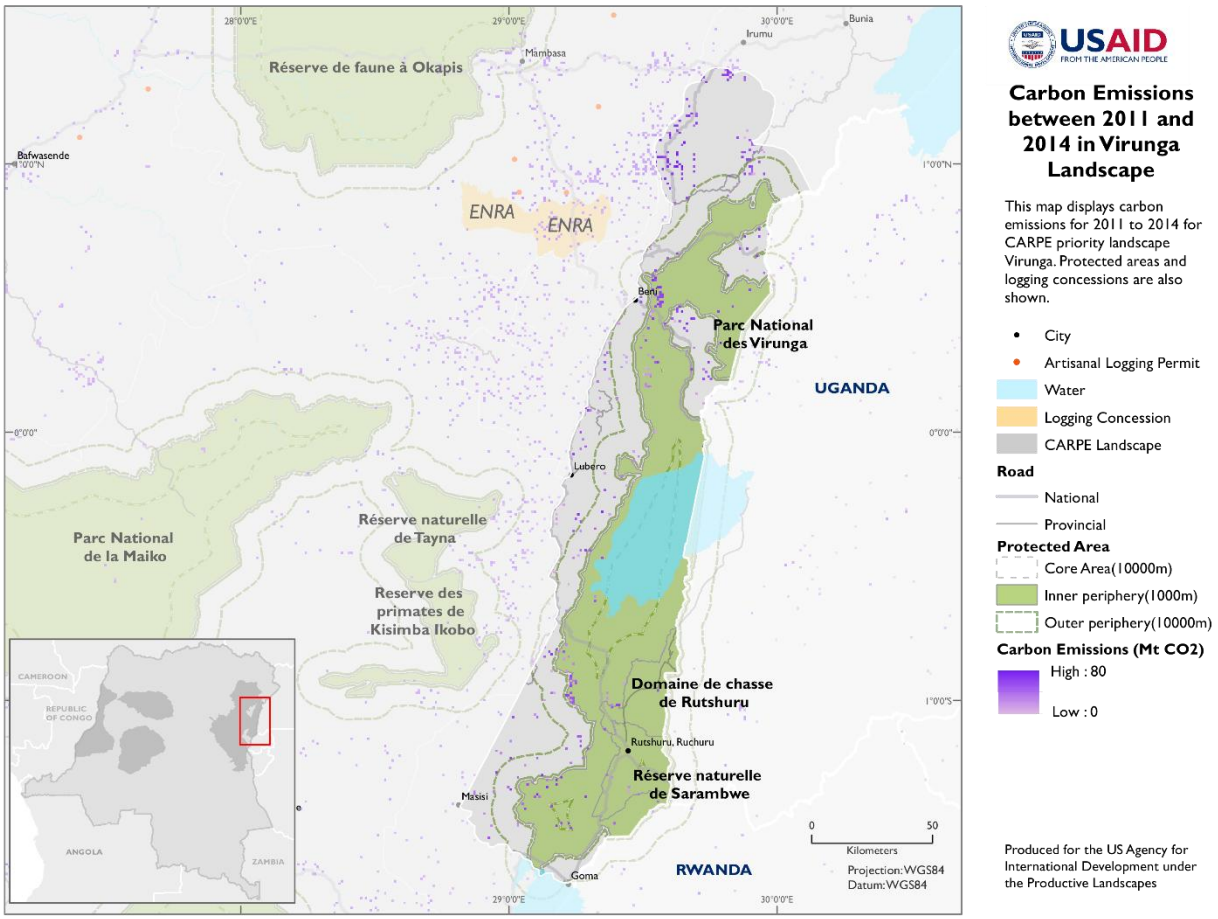
Map 11. Carbon Emissions 2011-2014 in Maringo-Lopori-Wamba Landscape (Forests)



Map 12. Carbon Emissions 2011-2014 in Salonga-Lukenie-Sankuru Landscape



Map 13. Carbon Emissions 2011-2014 in Virunga Landscape



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