Deforestation Trends in the Congo Basin

Reconciling Economic Growth and Forest Protection

WORKING PAPER 4 | Mining

Kirsten Hund
Carole Megevand

with

Edilene Pereira Gomes
Marta Miranda
Erik W. Reed

APRIL 2013

Deforestation Trends in the Congo Basin

Reconciling Economic Growth and Forest Protection

WORKING PAPER 4 | Mining

Kirsten Hund
Carole Megevand

with

Edilene Pereira Gomes
Marta Miranda
Erik Reed

Africa Region
THE WORLD BANK

APRIL 2013

CONTENTS

FIGURES

TABLES

BOXES

ACRONYMS

ARM	Alliance for Responsible Mining
ASM	artisanal and small-scale mining
BBOP	Business and Biodiversity Offsets Programme
CEMAC	Economic and Monetary Community of Central Africa
CMEC	China National Machinery and Equipment Import and Export Corporation
ECCAS	Economic Community of Central African States
EIA	environmental impact assessment
EITI	Extractive Industries Transparency Initiative
FIFO	fly-in/fly-out
GHG	greenhouse gas
ICGLR	International Conference of the Great Lakes Region
IFC	International Finance Corporation
MEG	Metals Economics Group
NGO	nongovernmental organization
PDAC	Prospectors and Developers Association of Canada
PGE	platinum group element
REDD	Reducing greenhouse gases Emissions from Deforestation and forest Degradation
SEC	U.S. Securities and Exchange Commission
SESA	strategic environmental and social assessment
SIA	social impact assessment

ACKNOWLEDGMENTS

This working paper is one of the outputs of the global study *Deforestation Trends in the Congo Basin: Reconciling Economic Growth and Forest Preservation* conducted by a multidisciplinary team under the leadership of the World Bank at the request of the Central Africa Forests Commission (COMIFAC) to increase understanding of the deforestation dynamics in the Congo Basin.

The paper was prepared by Kirsten Hund and Carole Megevand, with contributions from Edilene Pereira Gomes, Marta Miranda, and Erik Reed. The team is grateful for useful guidance provided by Gotthard Walser, Remi Pelon, and Christopher Sheldon. The report was ably edited EEI Communications. Maps and illustrative graphs were prepared by Md. Aminul Islam.

The study benefited from financial support from various donors, including the Norwegian Trust Fund for Private Sector and Infrastructure, the Program on Forests, and the Trust Fund for Environmentally and Socially Sustainable Development.

Introduction

A region exceptionally endowed with mineral resources… but largely untapped

The subregion of the Congo Basin is home to a vast wealth of diverse mineral resources. These resources are either valuable metals (copper, cobalt, tin, uranium, iron, titanium, coltan, niobium, manganese, and gold) or nonmetals (precious stones, phosphates, and coal).

Mineral resources have largely been untapped so far. With the exception of the Democratic Republic of Congo, which has a long history of mining (mainly in the southeastern part of the country), the mineral wealth of the Congo Basin remains largely underdeveloped. Many factors have hampered the development of the mining sector, including these:

- Infrastructure is lacking. Political instability in the region over the past 20 years has resulted in a lack of investment in infrastructure, including transport infrastructure, which is vital for mining developments.
- Civil unrest over the past two decades has massively diverted investments away from the region. In some countries, armed groups have used mineral wealth as a source of funding during civil unrest.
- The investment climate is not conducive to doing business, owing to poor governance and a regulatory framework (including taxation) that has largely discouraged mining investments.
- The region's economies rely heavily on oil. Oil booms and the subsequent Dutch disease effect in most of the Congo Basin countries have distracted the government's focus from the need for economic diversification.

Promising Prospects

Prospects for the development of the mining sector in the Congo Basin are improving as a result of both internal and external factors. The decline of oil reserves pushes countries such as Gabon and Cameroon to diversify their economies by promoting the development of minerals and other sectors to offset the revenue gap that results from declining oil wealth. The increasing price of many minerals worldwide also drives interest from mining companies in the Congo Basin. The exploding global demand for minerals tends to benefit the Congo Basin countries.

High prices and new consumption paradigms have drastically changed the rules of the game of accessing resources in the Congo Basin. Mineral reserves that used to be considered financially unviable are now receiving much attention. The heightened interest from investors is directly reflected in the increased exploration activities in the Congo Basin. One major change observed over the past few years is the emergence of new types of deals in which investors offer to build associated infrastructure (including roads, railways, power plants, and ports) in exchange for security of supply. The burden of infrastructure investments is thus lifted from the host countries, which theoretically alleviates one of the major constraints.

The artisanal and small-scale mining (ASM) sector is very sensitive to price trends. Despite a strong government focus on large-scale mining, the ASM sector is still by far the largest mining sector in the Congo Basin. Gabon, Cameroon, Republic of Congo, Central African Republic, and Democratic Republic of Congo all have significant ASM sectors that directly employ from an estimated 10,000 people in Gabon to 2 million in the Democratic Republic of Congo.

Artisanal mining activities are proliferating all over the Congo Basin, including in protected areas and critical habitats.

How Could Mining Affect the Forest Cover?

Currently, the majority of industrial mining operations in the Congo Basin occur in nonforested areas. However, with prospects for increased mining developments in the region, it is also expected that effects on the forest will amplify. Such effects can occur at any stage of operations (for example, exploration, exploitation, or closure).

The nature of the potential impacts of mining operations on forests can be direct, indirect, induced, or cumulative. All these effects must be taken into account to reconcile mining development and forest wealth in the critical forest ecosystems of the Congo Basin.

The development of industrial mining in the Congo Basin creates competition with other land uses, including forestry and conservation interests. All countries in the Congo Basin face existing and potential land use conflicts among mining, agriculture, forestry, and conservation. These conflicts are largely the result of inconsistent levels of transparency and coordination across the natural resource sectors, and the absence of a consistent framework for the attribution and publication of natural resource permits and contracts, ensuring coherence across natural resource sectors. Artisanal mining, when done properly, can employ a significant number of people and contribute significantly to state revenues with limited damage to the environment. It can, however, also be a significant threat to biodiversity.

This report aims at providing stakeholders with a good anlaysis of the potential impacts of mining development on the Congo Basin forests. It is one of a series of outputs prepared during a two-year exercise to analyze and better understand the deforestation dynamics in the Basin. It presents the main findings of an analysis of the mining potential in the Congo Basin as well as the global trends in demand of minerals tries to identify ways to reconcile mining development and preservation of the Congo Basin forests. It is based on an in-depth analysis of the sector (past trends and future prospects).

The report is structured as follows:

- **Chapter 1** gives an overview of the mineral wealth in the Congo Basin.
- **Chapter 2** analyses the prospects for mining development in the Congo Basin;
- **Chapter 3** assesses the potential impact of mining developments on forests
- **Chapter 4** tries to identify ways to reconcile mining development and preservation of the Congo Basin forests.

CHAPTER 1

Mineral Wealth in the Congo Basin: Largely Untapped

The subregion of the Congo Basin is home to a vast wealth of diverse mineral resources. These resources are either valuable metals (copper, cobalt, tin, uranium, iron, titanium, coltan, niobium, manganese, and gold) or nonmetals (precious stones, phosphates, and coal). While they can be found in all countries in the subregion, the country with the richest deposits is the Democratic Republic of Congo (see table 1.1 and figure 1.1). These minerals are worth billions of dollars on the world market, but the potential remains largely untapped. The rise of world prices for many minerals has led to an increased interest in mining in the subregion, which will inevitably have a negative impact on the forest ecosystems.

GEOLOGY AND ASSOCIATED MINERAL RESOURCES

The geology of the region essentially involves the Congo craton, the mobile Proterozoic belts, and the Congo Basin (figure 1.1). Most natural resources are located in mobile Proterozoic belts and in the craton region emerging around the Congo Basin.

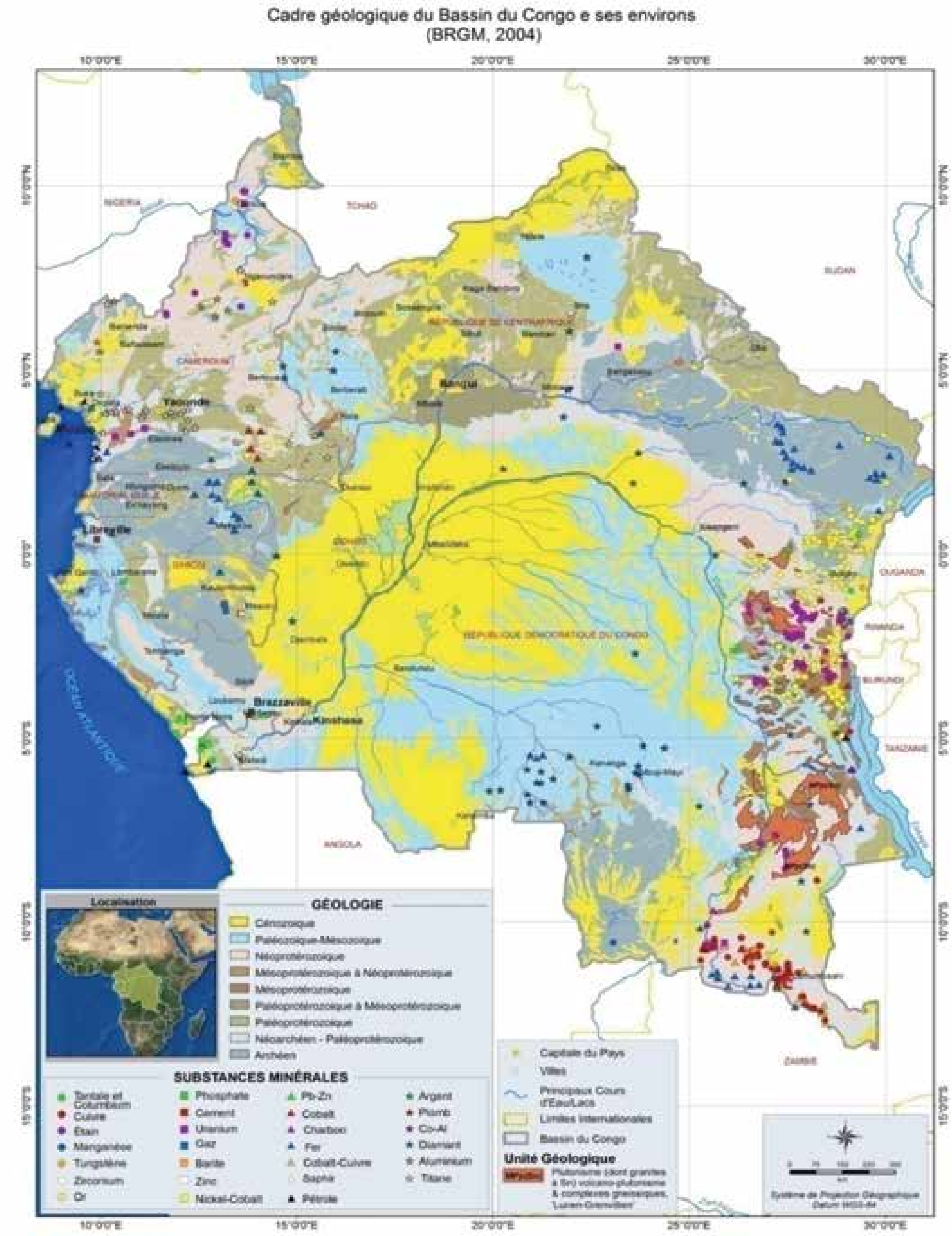
The Congo Basin is a geologically younger entity inside the craton. In the Atlantic basins of Equatorial Guinea, Gabon, Cameroon, and the Republic of Congo, oil is by far the most important resource; mineral wealth is associated with layers of phosphate, chloride of

Table 1.1: Common Minerals in Congo Basin Countries

Mineral	Country
Gold	Equatorial Guinea, Gabon, Rep. Congo, Dem. Rep. Congo, Central African Republic, Cameroon
Diamonds	Gabon, Congo, Dem. Rep. Congo, Central African Republic, Cameroon
Iron	Gabon, Rep. Congo, Dem. Rep. Congo, Cameroon
Uranium	Gabon, Rep. Congo, Dem. Rep. Congo
Lead	Gabon, Rep. Congo, Dem. Rep. Congo
Tin	Rep. Congo, Dem. Rep. Congo, Cameroon
Aluminum	Rep. Congo, Dem. Rep. Congo, Cameroon
Manganese	Gabon, Dem. Rep. Congo
Copper	Rep. Congo, Dem. Rep. Congo
Titanium	Congo, Cameroon
Cobalt	Dem. Rep. Congo, Cameroon
Niobium	Gabon

Source: Reed and Miranda 2007

Figure 1.1: Geological Map of the Congo Basin and Its Surroundings



Source: BRGM 2004

potassium, uranium, gold, diamonds, and charcoal. Cameroon has the highest alluvial deposits of titanium. Layers of bauxite (aluminum), lateritic (Cenozoic) of Minim-Martap, Ngaoungdal, and Fongo Tongo (Cameroon) total about 1.2 billion tons.

The Congo craton is defined as the most ancient (archaic) portion of the continental crust; it is located in the central part of the African continent and surrounded by tectonic Proterozoic provinces called "mobile belts." Craton centers have high concentrations of iron and gold deposits associated with green rock belts (volcanogenic sequences), especially the iron province located on the border between Cameroon, Gabon, and the Republic of Congo. Mobile belts, where the earth's crust shrinks under the influence of compression forces, represent the great majority of existing mineralization in the region. A huge variety of mineral resources is associated with these geological entities: copper, cobalt, manganese, uranium, gold, plumb-zinc, and diamonds.

Although industrial or artisanal and small-scale mining may be present at various locations in the countries, five mineral provinces of major importance stand out: (1) the cupriferous belt of Katanga, southern Democratic Republic of Congo;[1] (2) the auriferous province in the Democratic Republic of Congo; (3) the bauxite (aluminum) province in the central-north region of Cameroon; (4) the iron province on the border of Cameroon, Gabon, and the Republic of Congo; and (5) the nickel and cobalt province of Cameroon.

The copper-cobalt belt that runs between the Democratic Republic of Congo and Zambia contains 34 percent of the world's reserves of cobalt and more than 10 percent of copper reserves. The province of Katanga in the Democratic Republic of Congo possesses the world's second largest cupriferous belt. These reserves are estimated at 70 million tons of copper and 5 million tons of cobalt. Copper mining has been done in Katanga province since colonial times; currently, thousands of individual miners and about five major exploitation operations are working in Katanga.

Although the reserves of copper and cobalt are the most important, the mineralization of plumb, zinc nickel, germanium, gallium, uranium, manganese, gold, silver, and the platinum group element (PGE) are also present. The eastern part of the Democratic Republic of Congo also has the most important concentrations of stannite, tan-tale, lithium, molybdenum, beryllium, wolfram, niobium, arsenic, and gold in the region of interest; cassiterite, wolframite, and coltan are found primarily in North and South Kivu and Maniema provinces. Most of the exploitation is carried out by artisanal and small-scale miners. However, with the end of the war, one major industrial company has started exploration and mine development activities in South Kivu province.

Province Orientale and South Kivu in the Democratic Republic of Congo are the most important producers of gold in the Congo Basin. However, gold is also found in the Central African Republic, Cameroon, and Gabon. In Orientale, several industrial operations are in the exploration and feasibility stages. Some of these operations are adjacent to important national reserves and parks. The most significant diamond region in the world is found in the two Kasai regions of the Democratic Republic of Congo, but most are not of gem quality. Cameroon, Gabon, and the Central African Republic also have stores of diamonds, most of which are of gem quality.

Iron ore can be found in large deposits in the frontier between Cameroon, Gabon, and the Republic of Congo. Cameroon also has cobalt and nickel deposits in the southeast and bauxite in the north-central part of the country. Uranium can be found in Cameroon, Gabon, the Democratic Republic of Congo, and the Central African Republic. Phosphate and potassium chloride are found in the Republic of Congo, Gabon, and the Democratic Republic of Congo. Gabon is the third most important global producer of manganese (USGS 2012), which is essential for the production of steel.

MINING SECTOR IN THE CONGO BASIN

With the exception of the Democratic Republic of Congo, which has a long history of mining (mainly in the southeastern part of the country), the vast mineral wealth of the Congo Basin is largely undeveloped. Many factors have hampered the development of this sector:

1 According to some definitions, Katanga is not part of the Congo Basin, because it falls outside the large forest block that covers most of central Africa. It is included here because the Democratic Republic of Congo is considered to be one of the Congo Basin countries

- *Civil unrest over the past two decades.* The Democratic Republic of Congo has been in a state of protracted conflict since 1996, particularly following the Sun City Agreement in 2002. The Central African Republic has a history of political violence and instability. RC suffered an armed conflict between 1997 and 2003 that impoverished the country and caused considerable damage to the infrastructure and the national economy. RC, the Central African Republic, and the Democratic Republic of Congo have struggled with civil conflicts in which armed groups have allegedly used mineral wealth as one source of funding for their activities. Negative publicity about so-called "conflict minerals" from eastern the Democratic Republic of Congo, where revenues from illicit mineral extraction are used by armed groups to fund violence and insurrection, has discouraged some legitimate companies from investing beyond the more stable area of Katanga province (ICG 2012).
- *Lack of infrastructure.* Political instability in the region over the past 20 years has resulted in a lack of investment in infrastructure, including transport infrastructure. In the Democratic Republic of Congo, state mismanagement of resources over 30 years, sporadic looting, and two periods of armed conflict have destroyed the little infrastructure that existed. Limited transport and energy infrastructure has until now prevented Congo Basin countries from exploiting their natural resources, including minerals, at an industrial scale.
- *Nonconducive investment climate.* The investment climate is not conducive to doing business in the region. Poor governance, lack of clarity regarding land tenure, and heavy and often predatory taxes add to a risky investment climate (World Bank 2010).
- *Heavy reliance of economies on oil.* Oil booms and subsequent Dutch disease effects in most of the Congo Basin countries have distracted government's focus from economic diversification. For instance, in Gabon, despite low population and huge wealth in other natural resources, major capital inflows from the oil sector have locked the Gabonese economy into oil production.
- *Remoteness.* A large part of the Congo Basin's mineral wealth lies in inaccessible areas of dense rainforest. Mining with available techniques was not profitable for a long time; however, this situation is changing rapidly because of growing demand, infrastructure developments, and technical advances.

Types of Mining Operations

Minerals in the Congo Basin will be mined according to the nature of the deposit. The most commonly used techniques are (1) open-pit mining, (2) underground mining, (3) dredging, and (4) hydraulic monitoring; some of these techniques are currently in use in the region.

- *Open-pit mining.* Open-pit (or open-cast) mining is used for ore bodies that reach the surface but whose irregular size and depth require deeper excavation. Like strip mining, open-pit mining involves removal of the overburden, followed by excavation that creates concentric rings of terraces and platforms to form a deep pit. The terraces (or benches) create a series of stepped walls that increase the width of the pit as it reaches the surface. Depending on the size of the ore body, mining pits may be substantial, sometimes reaching several kilometers in width and up to a kilometer in depth.
- *Underground mining.* Underground mines are developed for mineral deposits that occur in vertical veins penetrating deep into the earth's crust, such as diamonds and other gemstones; lead, zinc, and salt; and some copper, gold, and coal deposits. The ore is extracted via vertical shafts or tunnels and carried to the surface by rail, conveyors, or elevators. Because underground mines are typically more expensive to build and operate, this method is usually used only when the characteristics of the ore and the value of the commodity make it an economically viable option.
- *Dredging.* Dredging is used by large-scale miners for alluvial deposits that occur under bodies of water, such as rivers and shallow seas. A boat equipped with an excavator sucks or scrapes the river or seabed, collecting sediments that contain

valuable minerals. In some cases, water jets are used to inject water at high pressure to create turbulence from which sediments can be extracted.

- *Hydraulic monitoring.* This technique is used to extract ore from weathered deposits. High-pressure hoses spray water on the ore body, dislodging it from the host rock. Miners gather the ore for further processing. Much of the waste is washed away into nearby rivers and streams.

Typology of Mining Operators

The mining industry in the Congo Basin features a dualistic sector that combines industrial mining operators and artisanal and small-scale operators. Artisanal and small-scale miners exploit deposits using rudimentary technologies to extract and process tin, tantalum, and diamonds in particular. For the artisanal mining of gold, toxic chemicals are used. Industrial operators usually rely on mechanized equipment to access ore bodies located beneath the surface. General types of mine operators include (1) artisanal or small-scale miners, (2) junior mining companies, and (3) large-scale/industrial mining companies.

- *Artisanal and small-scale miners.* ASM is an important and increasingly popular livelihood for tens of millions of people around the world. The definition of ASM varies by country.[2] Generally it is mining conducted with rudimentary tools such as picks and shovels or simple machinery, usually informally or semi-formally, by individuals or small groups, on a subsistence basis or as part of a strategic and diversified livelihood portfolio.

  ASM takes place all over the world, from Suriname to Liberia to Mongolia to Greenland. Artisanal and small-scale miners generally process small amounts of ore (less than 50 tons per year) using manual and semi-mechanized methods. At the smaller scale, miners may operate individually using pick axes, shovels, and pans to access and process alluvial deposits. Semi-mechanized operations may use a variety of mechanized tools and equipment to complement the manual labor force.

- *Junior mining/exploration companies.* A junior mining company is one that relies on financing from capital markets or private financing sources, while a senior miner generates its revenue from its mining operations. Junior mining companies vary in their involvement in the minerals production cycle. Some small companies are involved only in exploration, selling their claims to larger companies for development if they discover an economically valuable deposit. These players often engage in risky ventures, raising capital on major stock markets in the hope of discovering a major deposit. If a major deposit is confirmed, junior mining companies may also decide to develop the deposit themselves. The global restructuring of the mining industry in recent years has caused many larger mining companies to cut their exploration budgets, leaving much of the new global exploration in the hands of junior companies. Currently, junior mining companies from Australia, South Africa, Canada, and China are the major corporate players in the Congo Basin.
- *Large-scale mining companies.* Large companies are involved in all aspects of the mineral development process. All stages of development and processing are mechanized, requiring significant capital investments. Some major companies operate mines in several mineralized regions around the world, focusing either on a single commodity (for example, Anglo Gold Ashanti on gold) or on many mineral commodities (for example, Rio Tinto and BHP Billiton).

Mining in the Congo Basin Forest: Key Characteristics and Environmental Concerns

Each country in the Congo Basin has developed specific schemes for the use of its natural resources—particularly mineral resources—in response to its distinct political, economic, and social characteristics. However, they share a few key characteristics with regard to the

2 We will adopt the following characteristics for distinctions (E.Jaques, 2001): A *small mine* is an extractive enterprise of the SME type, administratively recognized and carrying out planned exploitation of a small but explored deposit with a minimum of fixed installations and mechanized equipment; an *Artisanal mine* is a generally informal operation, exploiting an unknown resource in an unplanned manner, using mostly manual methods and rudimentary tools/machinery.

management of their natural resources. (Equatorial Guinea does not currently have any known mining operations, so it is not included in the following analysis. For a short overview of the mining situation in each Congo Basin country, see the annex.)

Mining Sector: A Priority for Congo Basin Countries

All countries of the Congo Basin have significant experience with extractive industries, mainly through the exploitation of timber, oil, and gas. But with the exception of the Democratic Republic of Congo, mining has never played a major role in the development of most Congo Basin countries and has remained on the margins of the economy. With the demise of oil reserves, Cameroon, Gabon, and the Republic of Congo are making plans for economic diversification and development of a wide array of projects, including large infrastructure investments (ports, dams, roads, etc.), mines, oil/gas projects, and agro-industrial plantations.

Over the past five years, Gabon, Cameroon, the Central African Republic, the Republic of Congo, and the Democratic Republic of Congo have all gone through a process to overhaul their mining sectors through a series of legal and institutional reforms, as well as significant investments in geological research. The aim is to ensure that mining sector operations yield development outcomes at both the national and community levels.

These new policies, combined with higher commodity prices, have generated some investor interest and brought several (mainly junior) mining companies to the Congo Basin. As of May 2011, a significant number of large-scale projects were in advanced stages of exploration.

Large ASM Sector

Despite a strong government focus on large-scale mining, the ASM sector is still by far the largest mining sector in the Congo Basin. Gabon, Cameroon, the Republic of Congo, the Central African Republic, and the Democratic Republic of Congo all have significant ASM sectors that directly employ from an estimated 10,000 people in Gabon to 2 million in the Democratic Republic of Congo. Artisanal mining, when done properly, can employ a significant number of people and contribute significantly to state revenues, with limited damage to the environment. However, it can also be a significant threat to biodiversity (see chapter 2). The Democratic Republic of Congo, for example, is home to 66 million people, of which an estimated 16 percent (approximately 10 million people) derive their livelihoods from ASM (World Bank 2008). This economic reality has led the World Bank to describe the Democratic Republic of Congo's ASM sector as the most important segment of the mining sector (World Bank 2008). A significant portion of the ASM activity takes place in the country's east and overlaps significantly with protected areas and the most vulnerable ecosystems (for example, the mountains of the Albertine Rift).

Gabon also has a considerable but chaotic ASM sector. Artisanal mining has been associated with safety, health, and environmental issues such as encroachment on protected and fragile ecosystems (including bushmeat hunting and links with elephant poaching) and smuggling (Hollestelle 2012; Lahm 2002). According to some estimates, there are between 5,000 and 10,000 artisanal and small-scale miners in Gabon who primarily mine gold and (to a much lesser extent) diamonds.

Virtually all the diamonds and gold currently being produced in the Central African Republic are mined by artisanal and small-scale miners. The vast majority of diamonds and gold are mined in hundreds of small sites spread across the west and the center of the country. ASM is an important livelihood for around 400,000 women and men in the Central African Republic and provides more than 60 percent of the country's export earnings (Levin 2010). In a country of approximately 4.4 million people, this means as much as 10 percent of the population is involved in artisanal mining. Most of the mining sites are in remote areas, far from modern infrastructure or government oversight.

ASM often takes place deep in the forest, where most of the remaining vulnerable wildlife is found; thus, it is often linked to ivory poaching and bushmeat hunting. Transport links to isolated ASM sites are also used for ivory and bushmeat transport; miners themselves hunt around the sites; and small traders in ASM camps engage in ivory purchases (which with current high ivory prices, is very lucrative for hunters and traders alike). This observation is equally valid for RC and Gabon, where ASM often takes place in remote forest areas rife with elephant poaching.

Conflicting Land Uses

The development of industrial mining in the Congo Basin creates competition with other kinds of land use, including forestry and conservation interests. All countries in the Congo Basin face existing and potential land use conflicts among mining, agriculture, forestry, and conservation. This situation is largely the result of inconsistent levels of transparency and coordination across the natural resource sectors and the absence of a consistent framework for the attribution and publication of natural resource permits and contracts, which would ensure coherence across natural resource sectors (Nguiffo 2012). Figure 1.2 illustrates the situation in the TRIDOM region where mining concessions and National Parks sit in close proximity to one another if not overlap.

In all the Congo Basin countries, legislation is unclear about mining activities in and around different categories of protected areas, and about overlapping mining and forestry permits. A review by conservation organizations of the January 2011 Democratic Republic of Congo mining cadastre identified 629 mining permits that overlap with protected areas (Javelle 2012). The problem of overlapping land use is not restricted to mining concessions and protected areas. Research also shows that logging concessions overlap with protected areas and mining permits overlap with logging concessions and REDD+[3] projects. Contradictory laws, inconsistent information, and weak intergovernmental coordination create confusion, uncertainty, and misunderstanding among stakeholders involved in natural resource extraction in the region.

Cameroon is considering eliminating the obligation to reclassify an equivalent forest when forest is destroyed in the permanent forest estate. This means that mining, its associated infrastructure, and agro-industry could run wild in the forest and there will be no backup. If this happens in Cameroon, neighboring countries will likely follow suit.

Mining and Infrastructure Development

Depending on the international demand for commodities, principally iron and other base metals, additional projects could be developed within 5 to 10 years. This will present great opportunities in terms of growth and diversification but will also raise significant challenges, especially in terms of governance, infrastructure development, and associated environmental impacts. The development of the mining industry will catalyze the development of infrastructure for transport and energy. Projects of that size demand a high level of government stability, commitment, and coordination—even more so when mining operations take on a regional nature, as is the case with the Mbalam-Nabeba and Avima operations in the TRIDOM[4] (Tri-national Dja-Odzala-Minkébe) Interzone. Regional collaboration will be important to plan and coordinate on infrastructure development.

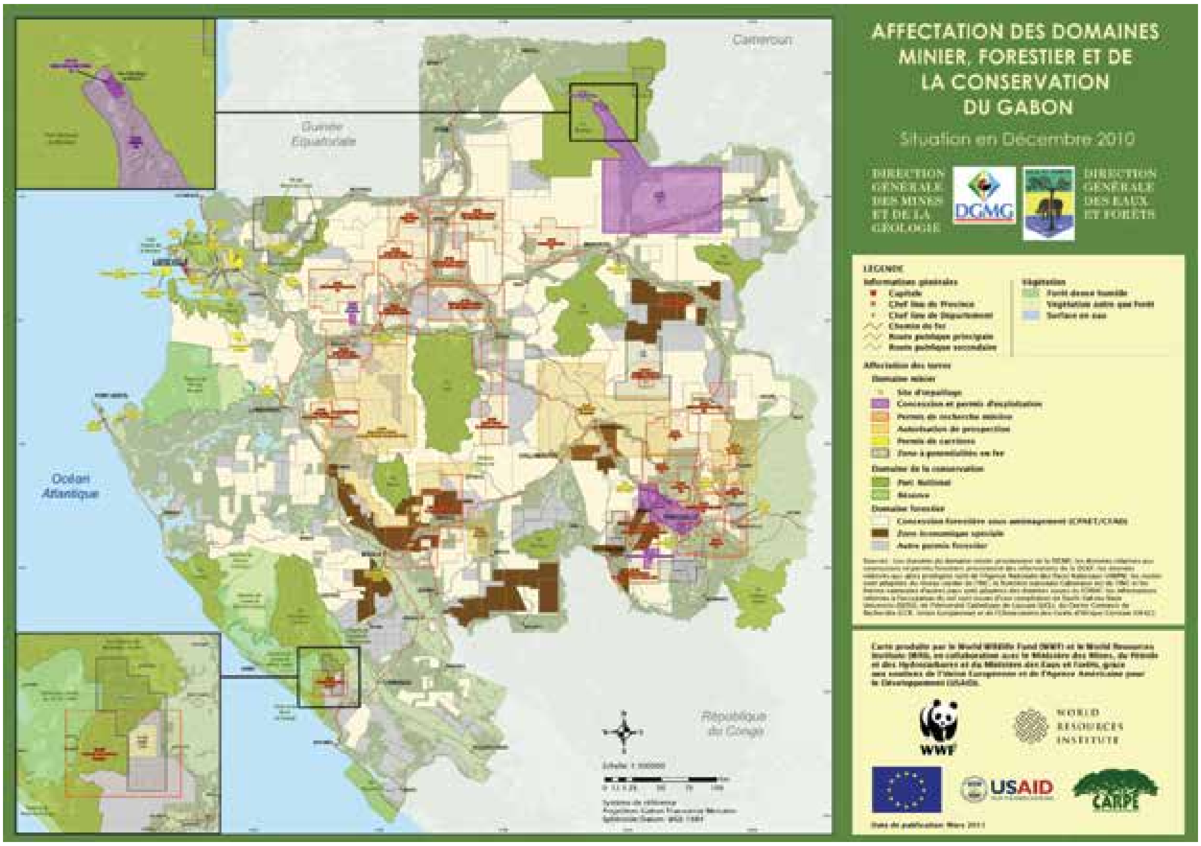
Limited Capacity to Monitor Environmental Impacts

The mining code in each of the Congo Basin countries requires companies to respect the environment. To get an exploitation license, a company must submit an environmental impact assessment and an environmental management plan. However, ministries of environment have limited capacity to review these reports. Other challenges include weak revenue transparency/sector governance and inadequate institutional capacity for policy formulation, contract negotiation, and sector monitoring, including mining inspectorates and cadastre offices.

3 REDD+ refers to reducing greenhouse emissions from deforestation and forest degradation and considering the role of conservation, sustainable forest management, and enhancement of forest carbon stocks in developing countries.

4 The Tridom, spread out over three countries (Cameroon, Republic of Congo, Gabon), covers 191,541 km², or nearly 10% of the Congo Basin rainforests and include nine protected areas.

Figure 1.2: Overlapping Mining and Forestry Concessions in Gabon



Source: General Directorate of Mining and General Directorate of Forests, Republic of Gabon, 2010.

CHAPTER 2

Prospects for Mining Development in the Congo Basin

Although lack of infrastructure, political instability, and globally depressed commodity prices precluded major investment in this region in the past, the rising price for many minerals worldwide is driving a new interest from mining companies in the Congo Basin. Reserves that used to be considered financially unviable are now receiving attention because of high prices and high demand.

TRENDS IN WORLD DEMAND FOR MINERALS AND LONG-TERM PERSPECTIVES

After 2000, the world demand for mineral resources increased significantly, reaching a historic high in the middle of 2008. This increase was mainly driven by global economic development, particularly China's strong growth. The pressure on demand was immediately followed by a major increase in metal prices which, in some cases, tripled.

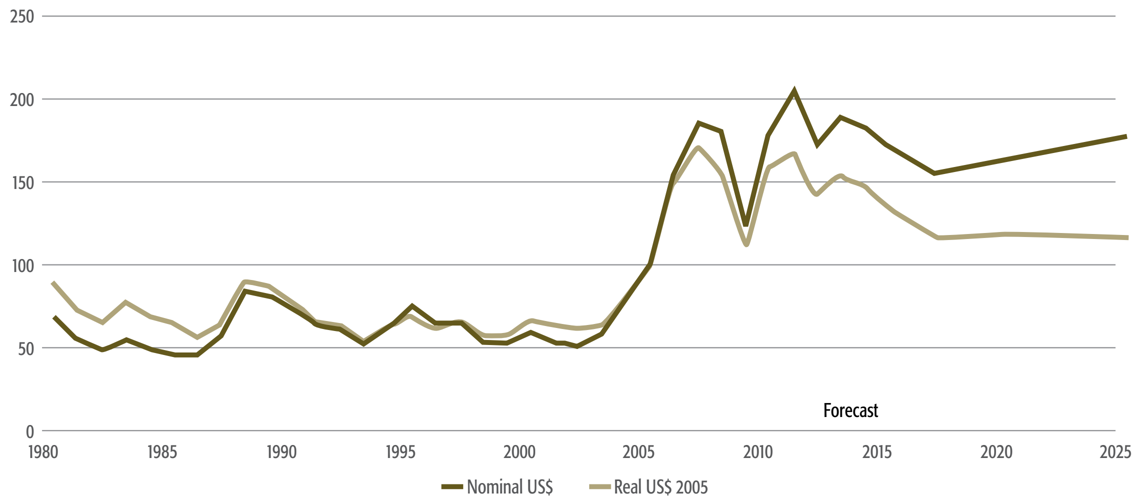
In mid-2008, the global recession began to strongly affect the mining sector. In early 2009, world demand for aluminum and copper dropped 19 percent and 11 percent, respectively. However, economic recovery in some emerging countries, especially China, boosted demand in the second semester of 2009 (figure 2.1). Strong industrial development and investment in infrastructure, construction, and the manufacturing industry in China led to a revival of demand for raw materials.

Between 2001 and 2006, China was the largest consumer of aluminum, cadmium, copper, iron, plumb, silver, and zinc. The country was also one of the main producers of these metals, except for copper and cobalt (seventh place). The United States was second after China as a consumer of most base metals, and India is a major consumer of precious metals and gemstones. Growth in the technology, transportation, and construction sectors will likely fuel greater demand for aluminum, cobalt, copper, iron ore, lead, manganese, platinum group metals, and titanium (see table 2.1).

As of 2010, China and other Asian countries imported the majority of the world's iron ore, manganese, lead, tin, aluminum, copper, cobalt, and titanium (see table 2.2). Europe and the United States continue to import significant but much smaller quantities of titanium, cobalt, aluminum, lead, iron ore, and manganese. The exceptions to these trends are uranium ore (imported predominantly by the United States); titanium (the United States, China, Germany, and Japan account for more than half of global imports); and diamonds (imports are shared equally among the United States, Belgium, and Hong Kong SAR, China). The last three commodities are used in high-end applications (power plants, aircraft, and jewelry, respectively), which traditionally have been dominated by richer countries. However, as the Chinese become wealthier, the import balance for these commodities is likely to tip in China's favor.

Most mineral commodities experienced sharp increases in price after 2000, especially during the second half of the decade. These increases were primarily owing to an exploding demand from China as well as global economic growth. While it is expected that the sharp increases will come to an end, high prices are

Figure 2.1: Evolution of and Forecast for Prices of Metals and Minerals (US$ Year 2005=100) (as of September 2012)



Source: World Bank, 2012b
Note: The price of mineral resources (including metals and iron ore) fluctuate according to consumption, production, stocks, opening and closing of mining fields, strikes, technological changes, and so on. Exogenous factors to the mining sector also induce price fluctuation, such as the depreciation of the U.S. dollar, major geopolitical changes in producers' countries, and, more recently, a rapid growth of emerging countries. Raw material price trends seem to have two main characteristics: (1) prices are based on cycles and (2) price fluctuations are weak in the middle of a cycle.

Table 2.1: Project Drivers of Demand for Mineral Commodities Found in the Congo Basin

Commodity	Major consumers	Economic sectors
Aluminum	China, India	Automotive, aerospace
Cobalt	Asia	Aerospace, batteries, catalysts
Copper	Asia and BRICs[a]	Building/construction, electrical
Diamonds	United States	Jewelry
Gold	India, China, Turkey	Jewelry
Iron ore/steel	China	Steel-making, building and construction
Lead	China	Lead acid batteries (vehicles)
Manganese	China	Steel-making, building and construction
Platinum group metals	China, United States	Automotive catalytic converters
Tin	China, Japan, United States, European Union	General industry (especially to replace lead solders)
Titanium	China, United States	Pigments and dyes, transportation (aircraft)

Source: USGS 2009, Mineral Commodity Handbook
[a] BRIC is acronym that stand for Brazil, Russia, India and China.

forecast for most of the commodities. These forecasts are of great importance for the Congo Basin countries, which have untapped wealth in most of these resources and could benefit from high prices to help their mining sectors develop.

Copper

Copper is the world's third most widely used metal, after iron and aluminum; it is primarily used in highly cyclical industries such as construction and industrial machinery manufacturing. Profitable extraction of the metal depends on cost-efficient high-volume mining techniques, and supply is sensitive to the political situation, particularly in countries in which copper mining is a government-controlled enterprise.

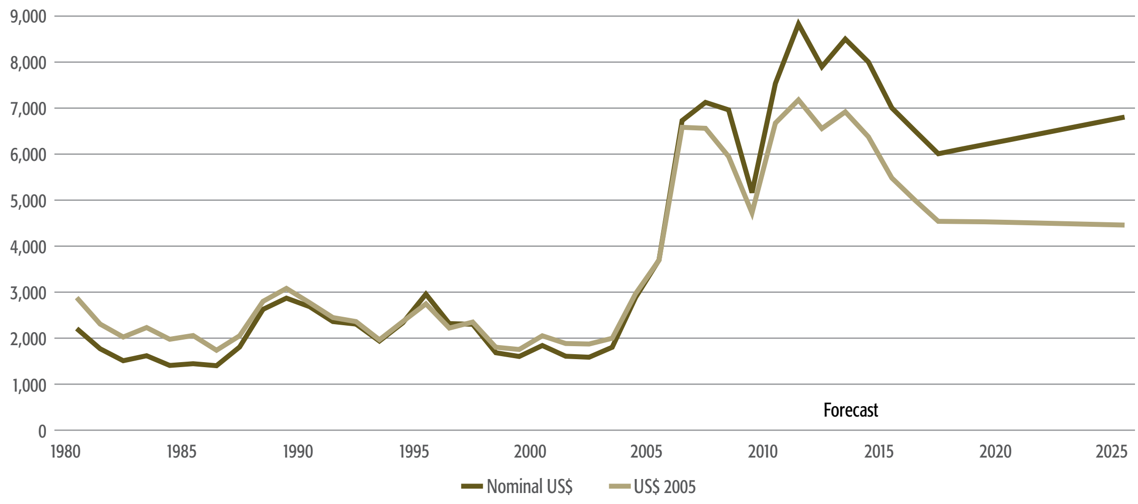
Between 2005 and the beginning of 2008, the price of copper tripled. This was followed by a decline owing to an excess of production before the global economic crisis (see figure 2.2). At the beginning of 2009, China played a fundamental role in the restart of copper demand and consequently in the price increase. Between 2010 and 2011, copper prices continued to rise as a result of a 6.5 percent increase in world demand and a decline in stocks.

Table 2.2: Major Importers of Mineral Commodities Known to Occur in the Congo Basin (2010)

Commodity*	Countries	Trade value (millions US$)	Share of value (%)
Aluminum	China	4,684.28	36.9
	United States	2,046.95	17.0
	Germany	793.65	6.6
	Spain	707.23	5.9
	Ireland	604.95	5.0
Cobalt	China	2,857.62	76.0
	Finland	468.24	12.4
	Zambia	303.87	8.0
Copper	Japan	40,831.89	32.5
	China	40,266.99	32.1
	Republic of Korea	10,154.05	8.1
	Germany	8,712.76	6.9
Diamonds**	United States	70,100.19	22.9
	Belgium	56,073.83	18.3
	China, Hong Kong	47,906.70	15.9
	Israel	33,025.45	10.8
Iron	China	224,369.97	62.3
	Japan	46,049.68	12.8
	Germany	15,852.91	4.4
	Republic of Korea	11,240.82	3.1
Lead	China	7,486.04	47.0
	Republic of Korea	1,791.29	11.2
	Japan	1,409.43	8.8
	Germany	1,390.77	8.7
	Belgium	1,175.83	7.4
Manganese	China	9,347.35	58.1
	Japan	1,380.60	8.9
	Norway	1,115.36	6.9
	Republic of Korea	718.58	4.5
Tin	Malaysia	488.88	40.7
	Thailand	435.81	38.3
	China	195.45	16.3
Titanium	United States	1,045.52	19.7
	China	743.96	14.0
	Germany	620.05	11.7
	Japan	476.20	9.0
Uranium	United States	2,479.31	98.8
	China	19.93	.8
	France	7.17	.3

Source: UN Comtrade Database 2012.
Notes: *Ores and concentrates, unless otherwise noted. **Other than sorted industrial diamonds, whether or not worked but not mounted or set.

Figure 2.2: Variation in and Forecast for Copper Price (US$/million tons; prices expressed in constant 2005 US$)



Source: World Bank, 2012b (Commodity Markets Database)

Chile accounts for over a third of the world's copper production, followed by China, Peru, the United States, Australia, Indonesia, Zambia, Canada, Poland, and the Democratic Republic of Congo. Major exporters of copper ores and concentrates are Chile, Peru, Indonesia, Australia, Canada, Brazil, Kazakhstan, the United States, Argentina, and Mongolia. The biggest importers of copper are China, Japan, India, Korea, and Germany (*Trading Economics* 2012).

Latin America and the copper belt of the Democratic Republic of Congo-Zambia are the most likely places where the production of copper will grow in the future. In the medium term, the opening of new minefields (including in the Democratic Republic of Congo) may cause prices to drop. In the long term, however, prices should remain well above the average price for the years 1980 and 2000 owing to strong investment costs in new minefields and a decrease in the mineral content of the mines.

Gold

Over the past decade, the value of gold has increased massively: 600 percent. It increased 30 percent in 2011 alone and is forecast to reach new record highs in the coming years (*Financial Times* 2011), which will drive continued interest in gold mining and gold concessions.

Gold is produced on every continent except Antarctica, where mining is prohibited. Several hundred large-scale gold mines are in operation around the world. The overall level of global mine production is relatively stable—supply has averaged approximately 2,497 tonnes per year over the past several years. This stability is attributed to the fact that new mine production is largely replacing depleted resources rather than significantly increasing production levels. Furthermore, gold production requires relatively long lead times, with new mines taking up to 10 years to come onstream. Thus, mining output is relatively inelastic and unable to respond quickly to changes in price. The World Gold Council says that even the sustained price rally over the past seven years hasn't translated into increased production (World Gold Council 2012). This said, with long-term forecasts predicting a continued upward trend and pressure on companies to replace the ounces they mine every year, ongoing and increasing exploration and the building of new mines is certain.

While jewelry is the greatest source of demand for physical gold investment, central bank reserves and the technology sector are significant. Each sector is driven by different dynamics, which helps support the strength of the gold price. According to the World Gold Council (2012), China is the second largest gold consumer, with a demand for gold that grew by nearly 14 percent in the first quarter of 2011 and is expected to double within the next decade. Jewelry accounts for 64 percent of China's consumption of gold, an increase of more than 100 percent over the past seven years. Investment in exchange-traded funds also rose sharply owing to concerns about debt defaults in Europe, inflation, and unrest in the Middle East and Africa.

The Congo Basin countries are not among the world's—or even Africa's—largest gold producers yet (see figure 2.3). However, they all have a large number of artisanal gold miners and gold exploration operations within their borders. These will continue to expand with the growing gold prices.

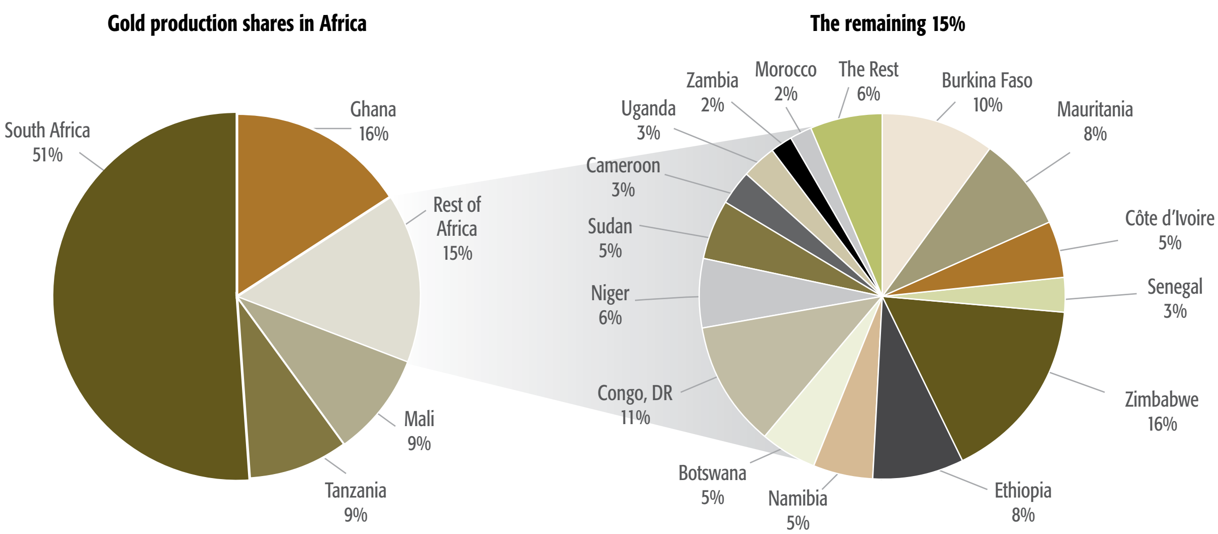
Iron Ore

Iron ore is the basic raw material for iron and steel and is therefore critical for all industrial economies. Australia and Brazil together account for about 50 percent of world production. China and the United States account for almost 39 percent of world consumption. During the 1990s, iron demand increased rather slowly; however, at mid-2000s, the demand strengthened, which caused a rather abrupt price increase (figure 2.5).

The production of iron ore and steel has closely followed industrialization trends. The United States and Western Europe were the major steel producers from the late 1900s until the first oil shock of the 1970s. Global steel production went into decline until the early 1990s, when globalization and industrialization in developing countries took off (ETC-RWM 2005). A major increase in the past five years has been attributed largely to China's rapid industrial growth. Soaring demand in Asia caused record growth in the steel industry in 2008, but demand slackened considerably toward the end of 2008 owing to the global financial crisis. Demand slowed in 2009, consistent with global economic trends.

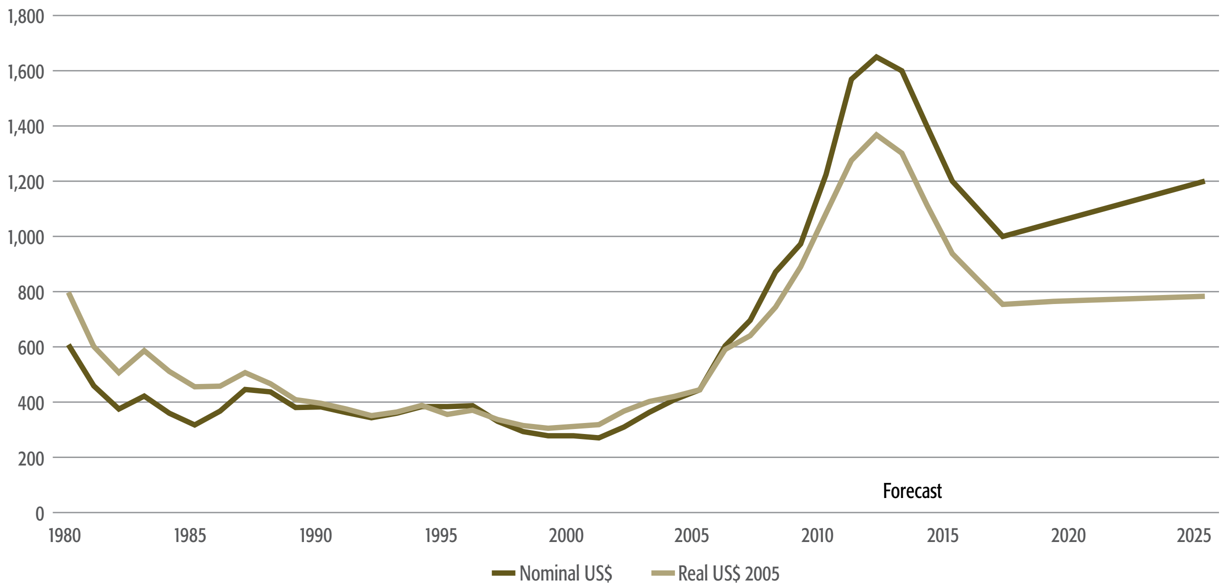
Global trends in iron ore consumption indicate that world demand is likely to continue to be driven by the demand from China. From 1996 to 2004, Chinese

Figure 2.3: Gold Production Shares in Africa



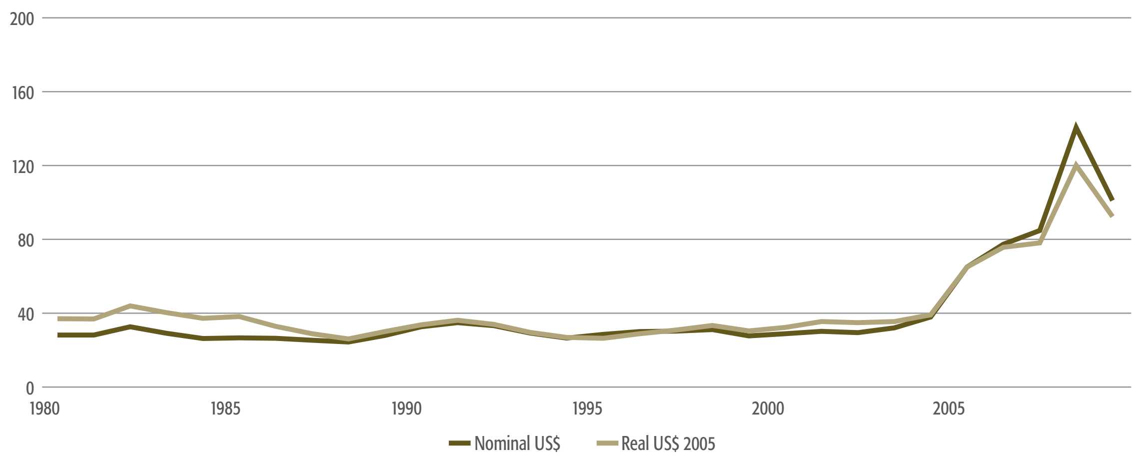
Source: USGS 2010.

Figure 2.4: Variation in and Forecast for Gold Price (US$/troy ounce; prices expressed in constant 2005 US$)



Source: World Bank, 2012b (Commodity Markets Database)

Figure 2.5 Variation in and Forecast for Iron Price (US$/dmtu-iron unit per dried metric ton; prices expressed in constant 2005 US$)



Source: World Bank, 2012b (Commodity Markets Database)

consumption of iron ore increased by 135 percent. China continues to be the world's largest importer of iron ore concentrates, accounting for 62 percent of global production (see table 2.2). Increasingly, Chinese interests are entering into overseas joint venture partnerships that allow them to identify and access iron ore reserves to satisfy the nation's demand. In 2010, China imported almost 60 percent of the world's iron ore exports and produced about 60 percent of the world's pig iron. International iron ore trade and production of iron ore and pig iron are key indicators of iron ore consumption; these percentages show that iron ore consumption in China is the primary factor determining the expansion of the international iron ore industry. The world iron ore market should continue to be tight, with demand exceeding supply until at least 2015, owing to the long lead time required to bring mines into production, a world shortage of skilled labor, and growing natural resource nationalism (USGS 2012).

Declining economic growth in China is directly affecting iron ore prices, which started to decline in 2012; in September 2012, they were at their lowest level since 2009 (USGS 2012). Opinions seem to vary on whether these low prices are here to say for the years to come or whether they will go up again in the near future. The fall in steel prices and demand, and the subsequent fall in iron ore prices, will make it harder for iron exploration projects in the Congo Basin rainforest to raise the necessary funding, though this could be offset by transport and energy infrastructure investments in the subregion.

Aluminum

Aluminum, made from bauxite, is largely used in the transport industry (airplanes, cars, space engines) and in the construction of houses, apartments, and commercial buildings. Consumption almost doubled over the past five years. There are only seven bauxite-rich areas in the world: Western and Central Africa (mostly Guinea); South America (Brazil, Venezuela, Suriname); the Caribbean (Jamaica); Oceania and Southern Asia (Australia, India); China; the Mediterranean (Greece, Turkey); and the Urals (Russia). Guinea contains 30 percent of the world's reserves and accounts for 94 percent of African bauxite production. The main deposits of high-quality bauxites with high aluminum content (not less than 50 percent) are already divided among the main players. Others must either buy alumina on the free market (and wholly depend on price movements) or join forces with deposit owners.

Aluminum prices were severely affected by demand compression shortly after the crisis of 2008, and production was not able to adapt fast enough. But by the end of 2009, the surplus stocks had been absorbed and prices began to recover. At the beginning of 2010, the global economic recovery (especially the strong increase of demand in China) supported these increases, which continued into 2011.

Cameroon has a smelter and vast potential for bauxite in terms of quantity, but significant uncertainties exist with regard to the quality of its reserves. Over the past 10 years, there have been talks of building an aluminum smelter in the Democratic Republic of Congo, powered by hydropower, but so far this has not materialized.

Potassium Chloride

The main use of potassium chloride is the manufacture of liquid fertilizer. The development of commercial agriculture caused a strong increase in the price of potassium chloride, which reached a historic high in 2009 because of its high use in Brazil. The world financial crisis caused prices to drop significantly after 2009 (figure 2.7). The price of this raw material is predicted to fall over the medium to long term.

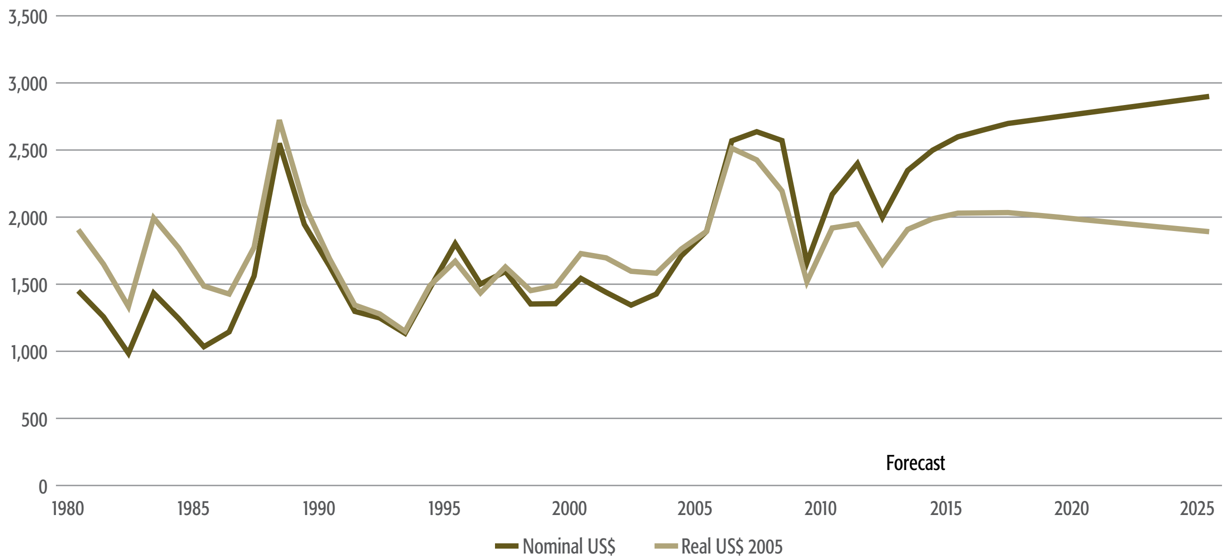
Cameroon, Gabon, and the Republic of Congo are known to have significant reserves of potassium. All projects are still in the exploration phase.

Coltan, Tantalum, and Nobium

Coltan (known industrially as tantalite) is a dull black metallic ore from which the elements niobium and tantalum are extracted. The niobium-dominant mineral in coltan is columbite, and the tantalum-dominant mineral is tantalite.

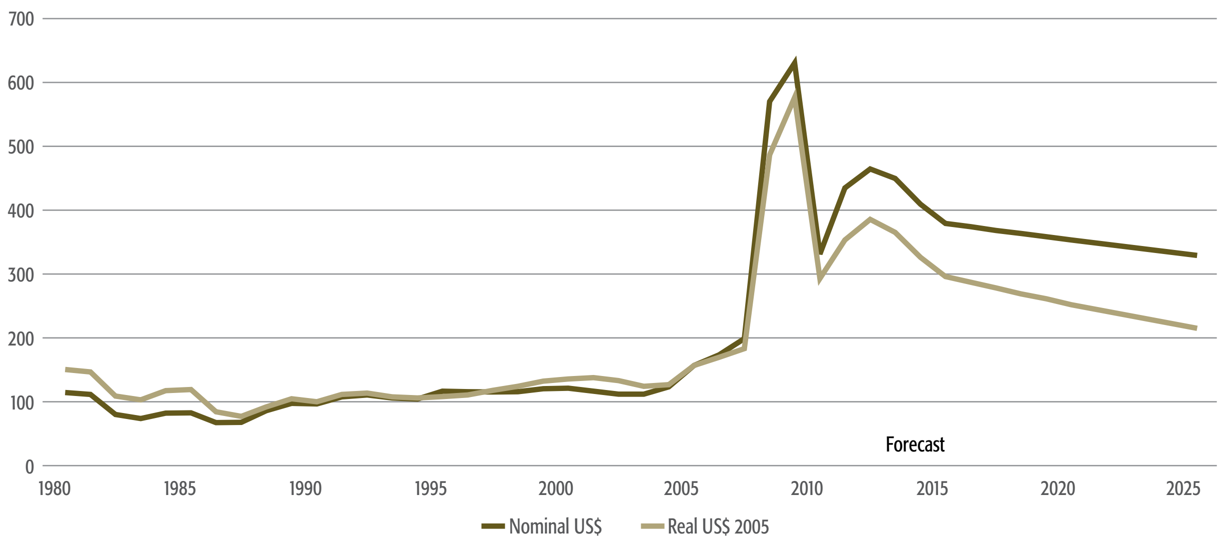
Tantalum from coltan is used to manufacture tantalum capacitors, used in electronic products. Coltan is used in the production of steel for electronic devices (for example, computers, cellular phones), aircraft engines, and alloys. Global consumption of coltan for these devices is expected to grow by 7 percent per year. The major producers of coltan ores are Brazil, Canada, and Australia, but the contribution from Africa—especially the Democratic Republic of Congo, Ethiopia, and Mozambique—is becoming significant.

Figure 2.6: Variation in and Forecast for Aluminum Price (US$/millions of tons; prices expressed in constant 2005 US$)



Source: World Bank, 2012b (Commodity Markets Database)

Figure 2.7: Variation in and Forecast for Potassium Chloride Price (US$/metric ton; prices expressed in constant 2005 US$)



Source: World Bank, 2012b (Commodity Markets Database)

Niobium and tantalum materials are not openly traded. Purchase contracts are confidential between buyer and seller; however, trade journals report composite prices of tantalite based on interviews with buyers and sellers, and traders declare the value of the niobium and tantalum materials they import or export. The price of tantalite ore peaked in mid-2005 at about 10 percent more than the pre- and post-peak price, after which it remained unchanged until it rose by more than 40 percent in 2007. In 2008, the tantalite ore price declined by 6 percent then remained unchanged. In 2009, the price continued to decline, decreasing by 22 percent to values similar to those reported in early 2007. The price of tantalite ore did not appear to have been driven up in 2008 as the prices of other metals had been; however, the subsequent decline of metal prices in 2008 and 2009 appeared to have affected tantalite ore (USGS 2009).

EXPLORATION AND PROSPECTS FOR THE CONGO BASIN COUNTRIES

In 2009, after consecutive years of budget increases for exploration activities, the mining industry drastically cut expenditures (by about $5.5 billion) in direct response to the financial crisis. However, responding to rising metals prices and more stable markets, most mining companies partially restored their exploration budgets in 2010, which resulted in a 45 percent increase in estimated worldwide nonferrous metals exploration spending compared with 2009.

Metals Economics Group's (MEG's) 21st edition of *World Exploration Trends 2012* reports a 2010 exploration budget total of $11.2 billion. In light of the severity of the downturn and widespread forecasts of a deep and protracted recession, the unexpected rebound in 2010 seemed particularly speedy and strong.

Exploration allocations for all regions increased to record highs in 2011, led by the largest dollar increases in Latin America and Africa. Latin America remained the most popular exploration destination, attracting 25 percent of global spending in 2011. Canada has been the industry's second favorite region for the past decade. Gold remained the leading target in the country, attracting more than two-and-a-half times the base metals budget. Eurasian countries make up the third largest region. Although gold remained the region's top target in 2011, base metals allocations increased at a faster pace.

Africa saw the biggest year-on-year percentage increase of all regions in 2011, claiming 15 percent of the world total and widening its lead over fifth-place Australia. After slipping to second place in 2010 behind the Democratic Republic of Congo, South Africa regained the top spot for planned spending in Africa in 2011. Burkina Faso rose from 12th in 2009 to 3rd in 2011, leading the rapid rise in gold exploration in West Africa in recent years. The increased efforts in West Africa translated into gold receiving more than half the African exploration total in each of the past two years. In contrast, after accounting for about a third of African budgets in 2004, diamond allocations dropped to an all-time low of 6 percent in 2011, primarily because of waning diamond spending in Sub-Saharan Africa, as many companies focused more on countries such as Russia and India (MEG, 2012).

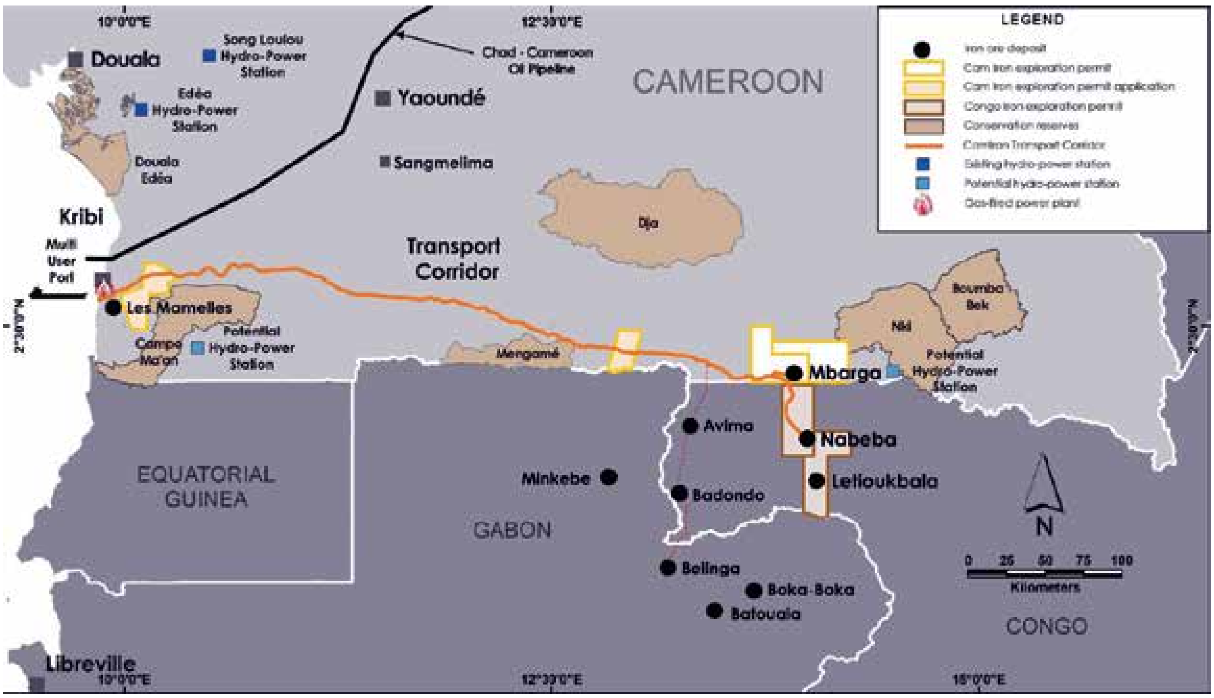
NEW DEALS: INFRASTRUCTURE BURDEN LIFTED FROM HOST COUNTRIES

Poor infrastructure has generally been a major obstacle in the development of mining operations in the Congo Basin. However, the high demand and high prices for minerals provide strong incentives to develop new mineral deposits, and a new generation of deals is expected. In fact, the past few years have seen a trend toward investors offering to build associated infrastructure; these projects can be substantial, including roads, railways, power plants (including large dams), and deep seaports.

In Gabon, the Belinga iron ore reserves were put under contract for development by China National Machinery and Equipment Import and Export Corporation (CMEC), which was also supposed to build the related infrastructure. In Cameroon, an Australian company (Sundance Resources Limited) has been allotted exploration rights and recently signed a contract that will—if the project is approved—involve the development of an iron ore mine and the related infrastructure, which falls within the dense tropical forests that cover the southern portion of Cameroon (see the map in figure 2.8). In the Republic of Congo, the Chaillu mining project is planning to renovate and enlarge the capacity of the old railway line that was previously used by COMILOG to transport manganese from Gabon to the harbor of Point Noir. There is also talk of developing at least one large hydropower project (Chollet Dam) in the Republic of Congo to provide electricity to the several iron mining projects in the border area between Gabon, Cameroon, and the Republic of Congo.

If they go through, these deals would remove a burden from the host countries, which generally do not have the financial capacity to cover large infrastructure investments. This would circumvent one of the major weaknesses of the Congo Basin countries for the development of mining operations.

Figure 2.8: Proposed Railway Line from Southeast Cameroon to the Coast



Source: from the operator Sundance Resources

CHAPTER 3

Potential Impacts of Mining Activities on Congo Basin Forests

More than a quarter of the world's active mines and exploration sites overlap with or are situated within a 10-kilometer radius of a strictly protected area. Nearly a third of all active mines and exploration sites are located within areas of intact ecosystems of high conservation value. Almost a third of all active mines are located in stressed watersheds (Reed 2007). These overlaps are often the case in the Congo Basin.

The potential impacts of mining operations on forests can be direct, indirect, induced, or cumulative. None can be disregarded and all must be taken into account to reconcile mining development and forest wealth in the critical ecosystem of Congo Basin forests.

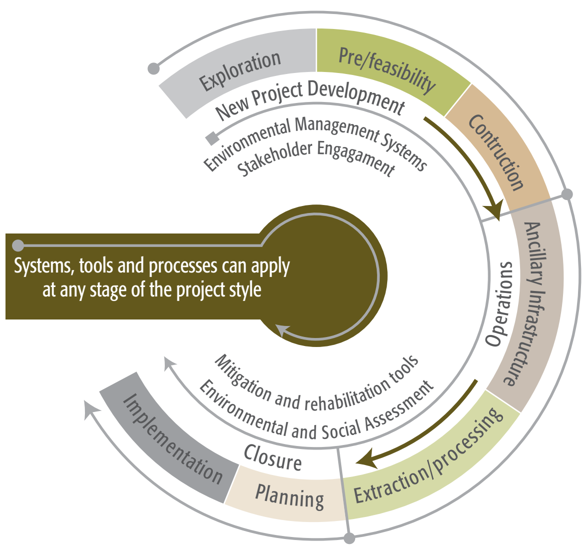
In discussing the impacts of mining on the Congo Basin forest, we must distinguish between large-scale/industrial mining and artisanal and small-scale mining. Currently, the majority of the large-scale mining operations in the Congo Basin occur in nonforested areas. However, as mining exploration and development increase in the equatorial forest region, so too will the impact on the forest. Impacts of mining operations on forests occur at different stages of the operations (exploration, exploitation, and closure) and can be direct, indirect, and cumulative.

DIRECT IMPACTS OF LARGE-SCALE MINING OPERATIONS AT DIFFERENT STAGES

The most serious direct environmental impacts resulting from large-scale mining are associated with decreased water quality and potential loss of aquatic habitat and species. While loss of terrestrial habitat and species can be severe per unit area (especially resulting from human activities such as logging and hunting), mining typically contributes very little to deforestation or forest degradation compared with other, more land-use-intense activities such as agriculture and logging. For example, an assessment of the state of Papua New Guinea's forests using remote sensing data found that mining itself caused only 0.2 percent of the country's deforestation and forest degradation between 1972 and 2002 (Pauli 2006).

As illustrated in figure 3.1, three major phases can be distinguished in the life of a mining project. Table 3.1 lists the potential environmental impacts of mining activities at different stages of operation. While much attention has thus far been given to the second

Figure 3.1: Cycle of Mining Operations and Related Environmental Management



phase (operations), it is clear that activities under the development phase and lack of actions under the closure phase can also be very detrimental to the environmental equilibrium and forest ecosystems.

Exploration Activities

Exploration—a high-risk, high-reward activity—has the goal of discovering economically viable mineral deposits; that is, those that can be mined at a profit. It takes time and great effort, often in remote areas, and is seldom successful. The chances of bringing a raw prospect into production have been estimated at 1 in 5,000–10,000. Furthermore, following a promising discovery, it can take up to 10 years to get to the production stage of starting a new mine.

Table 3.1: Potential Environmental Impacts of Large-Scale Extractive Industry DevelopmentSource: Adapted from Miranda et al. 2003.

Stage	Activities	Potential impact
Exploration/ prefeasibility	Geophysical/airborne surveying Drilling/trenching Trench blasting Exploration camp development Road construction	Habitat loss/fragmentation Sediment runoff, increased suspended sediment load to surface waters Disturbance to wildlife and local communities Species loss due to hunting Spills of fuels and other contaminants Increased colonization due to road building
Construction/ancillary infrastructure	Mine/well construction Infrastructure development (power lines, roads) Pipeline construction Mine camp construction Creation of waste rock piles Creation of low- and high-grade ore stockpiles Creation of waste impoundments Blasting to release ores	Habitat loss/fragmentation Chemical contamination of surface and groundwaters Declining species populations Toxicity impacts to organisms (terrestrial and aquatic plants and animals) Altered landscapes from mine/well workings (for example, open pits, changes in stream morphology) Increased demand for water resources Increased demand for electrical power Increased erosion and siltation Altered patterns of drainage and runoff Dust/fumes from explosives CO_2 emissions (gas flaring) Increased colonization due to road development Species loss due to hunting Increased domestic violence and prostitution Mine worker accidents resulting in death or disability Community resettlement and possible human conflict
Extraction/primary processing	Milling/grinding ore Ore concentration through chemical leaching, flotation, electrowinning, or gravity separation Oil concentration in gathering stations	Discharge of chemicals and other wastes to surface waters Emissions of sulfur dioxide, nitrous oxides, and heavy metals (lead, arsenic, cadmium) Increased demand for electrical power Habitat fragmentation due to oil pipelines Oil spills from pipelines
Extraction/secondary-tertiary processing	Smelting/refining	Emissions of sulfur dioxide, nitrous oxides, and heavy metals (lead, arsenic, cadmium) Increased demand for electrical power Discharge of chemicals and other wastes to surface waters Off-gassing and toxic dusts
Product transport	Packaging/loading product Transport via sea or land Infrastructure development (ports and roads)	Noise disturbance Greenhouse gas emissions related to fuel use Pollution of waterways from shipping accidents
Mine closure/ postoperation	Reseeding/revegetation Recontouring waste piles/pit walls Fencing dangerous areas Monitoring seepage	Persistent contaminants in surface and groundwaters Expensive, long-term water treatment Persistent toxicity to organisms Loss of original vegetation/biodiversity Windborne dust Permanent landscape changes Abandoned pits/shafts that pose hazards and health risks to humans

Exploration, or the search for viable ore bodies, can be broken down into greenfields and brownfields exploration. *Greenfields*, as the name implies, attempts to find ore bodies in new areas or areas that have historically shown good results. *Brownfields*, on the other hand, typically refers to exploration activities on the existing ore body/mine complex or relatively close to it, so it can be mined as part of the established infrastructure of the mine. The exploration process occurs in stages, with the social and environmental impacts generally becoming more notable as the project progresses.

Exploration initially involves aerial surveys and the use of satellite imagery and remote sensing to determine the potential for mineral deposits. If these initial activities prove promising, on-the-ground surveying and core testing are conducted to determine the presence and economic viability of the deposit. Although early exploration is relatively benign with respect to environmental impacts, later stages in the process can cause significant disruption to terrestrial and aquatic ecosystems if activities are executed without proper environmental safeguards. The late exploration phase may include the use of drill rigs and construction of underground tunnels for detailed drilling and mapping. This stage can cause habitat fragmentation resulting from land clearing for roads, trenches, and other access routes used to transport heavy machinery. In addition, these access routes often serve as conduits for human immigration and new settlements in previously uninhabited forest. As these settlements become permanent, agriculture and hunting/poaching over large areas can have a disruptive effect.

Actions can be taken to limit the damage of exploration activities on surrounding natural areas. Environmental impact assessments before exploration can help mitigate potentially harmful repercussions from mining. The Prospectors and Developers Association of Canada (PDAC) E3Plus Framework for Responsible Exploration offers guidelines on how to minimize these impacts (PDAC 2012). The guidelines can help exploration companies improve their social, environmental, and health and safety performance, and comprehensively integrate these three aspects into all their exploration programs. However, human migration dynamics following the creation of access are different in Africa than in Canada and would require specific guidelines.

Construction

Construction typically includes the following activities:

- Site preparation
- Clearing and initial preparation for mining (that is, overburden removal)
- Construction of accommodations
- Construction of process and site facilities (for example, mills, offices)
- Building roads and airstrips (installation of power lines and railway)

At the site itself, the extent of disturbance is a function of the ore grade and the type of mine operation (that is, strip mine versus underground). Typically, open-pit and strip mining operations create the most land disturbance, especially in areas where the ores are deposited slightly deeper. Thus, from an intensity basis, diamonds and gold have overburden and waste rock values that are orders of magnitude larger than those of other commodities, while base metals (copper, zinc, lead, nickel) and aluminum account for the largest footprint on an absolute basis.

Mine site construction and ore extraction require vegetation and topsoil removal. Land clearing for site construction and mineral excavation increases the potential for significant soil erosion and sedimentation. If topsoils are not set aside and conserved for the reclamation phase, restoration of the forest ecosystem will be difficult, if not impossible. In addition, soils that are not conserved can be washed away into nearby rivers and streams, causing sedimentation that can destroy aquatic habitat and result in a decline in fish species.

Processing

Primary processing generally occurs at the mine site and consists of chemical, electric, or physical methods to separate the mineral from the ore body. The main concern at this stage is chemical and waste management. Small-scale operations often discharge processing waste directly onto the ground or into waterways. Large-scale operations process high volumes of ore in a facility that might use significant quantities of water and energy. Effluents are typically discharged into artificially created holding ponds known as tailings impoundments. The effluent might contain trace amounts of mercury, cyanide, the target mineral, and other processing reagents. Disruptions in water cycles and water quality can lead to forest degradation, with changes in species composition and structure, and loss of biodiversity.

Closure and Rehabilitation

Mine closure and site rehabilitation take place after all economically viable minerals have been extracted. In large, well-run operations, planning for site rehabilitation often occurs during the exploration phase. Closure and site rehabilitation typically involve capping waste rock dumps to prevent acid mine drainage and other toxic effluents, replacing topsoils, recontouring the landscape, and revegetation. The site should be returned to a state that is deemed useful for the region's population, if not equivalent to the original landscape.

In less responsibly mined sites, closure and site rehabilitation may be given short shrift; if funds are not available, little or no rehabilitation may be conducted. Funding for closure and rehabilitation is a key requirement, and not all companies set aside sufficient funds for this stage of the process. Because the mine is no longer economically profitable and the closure process can be costly, smaller companies and individual miners have less incentive to properly close the site and return it to valuable use for local communities. The lack of capacity of governments of the Congo Basin to manage postmining site rehabilitation will further aggravate this situation.

Restoring the tropical forest ecosystem is challenging and costly. Studies of forest restoration in a former bauxite mine site in Brazil have shown that such efforts are successful only when considerable care is taken to prepare the site and preserve and replace topsoil removed in the excavation stage (Parrotta 1997). Even when best practices for restoration and reclamation are used, the forest ecosystem has been modified from its original, premining state (Parrotta 1997). This can cause localized yet significant habitat alterations that can lead to species extinction. Research has consistently shown that large mammals and smaller nocturnal mammals in the Congo Basin are especially vulnerable to the changes in vegetation and canopy cover that accompany forest clearings (Laurance 2008a).

Poorly run mines are likely to have a much more significant direct impact on forests than those that are operated according to international best practices. This is one of the reasons why artisanal mining, which is mostly nonregulated, can be so devastating. Best practice environmental management implemented according to the mitigation hierarchy (avoid-minimize-mitigate-compensate) requires companies to set aside sufficient capital, a challenge for many of the junior companies with interests in the Congo Basin.

One of the biggest challenges for the development of mineral extraction in the Congo Basin is the lack or poor quality of infrastructure. Early mining development in a region typically requires large investments in physical infrastructure. There will be a need to improve or develop roads or railroads to transport the minerals to ports or neighboring countries. This will increase the overall costs of production. With the improvement or introduction of new infrastructure, a percentage of the mineral endowment economically translates into commercially viable mines. In short, the availability of or potential to develop infrastructure is a deciding factor in the development of a mine.

INDIRECT IMPACTS RESULTING FROM INFRASTRUCTURE ASSOCIATED WITH LARGE-SCALE MINING OPERATIONS

Infrastructure development is also the most important threat to ecosystems, through physical incursion into forests and disruption of ecosystems.

Transport Infrastructure

Road and railway development could be particularly harmful. Building a new road means direct deforestation by tree cutting, but this impact is generally limited. More important, roads are the major vehicle for forest degradation through incursion into forest areas for agriculture, hunting, artisanal mining, and other potentially harmful activities (see induced impacts in the following section). Road building can also have a significant impact on local wildlife populations through habitat fragmentation. Roads can become a barrier that some species are unable to cross, effectively reducing their available habitat. For example, roads were found to have a significant impact on large and small ungulates (for example, duikers, sitatungas, and forest elephants) in Central African forests (Laurance 2008b). This barrier effect becomes much more severe when settlement occurs along the new roads and the forest effectively becomes fragmented.

Dams and Hydropower Plants

A large-scale mine has considerable energy requirements, especially during the processing phase. Energy requirements are typically highest for bauxite and aluminum production, iron ore, copper, diamonds, and gold. In the Congo Basin, these energy requirements will most likely be met via hydropower. Indeed, large-scale mining will not be possible without significantly increasing the regional power grid.

Construction of new dams or increasing the capacity of existing ones will have a significant impact on aquatic species and, to a lesser extent, on forests, depending on the size of the reservoir built. Construction of power lines could also result in fragmentation of forest habitat, especially if they are accompanied by access roads. On the other hand, hydropower results in a lower greenhouse gas (GHG) footprint than the usual energy sources (for example, coal, natural gas). Potential dam development around waterfalls and rapids in protected areas in Gabon and the Republic of Congo has recently caused unrest with conservationists.

INDUCED IMPACTS OF LARGE-SCALE MINING OPERATIONS

Mining operations are usually accompanied by a large influx of people looking for job opportunities. This induces additional socioeconomic activities, such as subsistence agriculture and poaching, with potentially significant harm to forests as well as armed conflicts.

Agricultural Expansion

An influx of workers to mining sites tends to directly increase pressures on natural forests through clearing for agriculture uses and energy needs. In addition, new roads tend to drastically change the economic equation in a specific area and can make unprofitable activities become profitable, through better access to markets as well as inputs such as fertilizers.

Bushmeat Hunting

Bushmeat hunting is a serious threat to wildlife and contributes to resource degradation in areas that have been opened to extractive practices, oil and other mineral development, or logging. Roads associated with mining or logging operations restrict wildlife movement and encourage the use of animals for consumption. Disruption in wildlife can eventually lead to ecosystem disturbance. Roads that open up remote areas make commercial hunting (and fishing) in these areas economically attractive and enable the bushmeat to be transported to urban markets. If mine development leads to the opening of previously remote, difficult-to-access ecosystems, very specific measures will have to be taken to avoid widespread degradation of these ecosystems.

Logging

To the extent that previously inaccessible high-value forests are opened up, poorly planned mining can induce illegal logging. In this sense, roads (and potentially railway lines) are the primary driver linking mining and logging.

CUMULATIVE IMPACTS OF LARGE-SCALE MINING OPERATIONS

Of greatest concern in the Congo Basin countries is the lack of land use planning and coordination to ensure sustainable development in the region, especially with respect to the often conflicting allocation of logging and mining concessions, the development of associated infrastructure, the potential for agricultural expansion, and the lack of control over the bushmeat trade and human settlement. Numerous conflicts have been noted between and among conservation priorities, mining and logging concessions, infrastructure development, and livelihoods of local populations. For example, a map of projected land use in the Sangha Tri-National Park region indicates that logging and artisanal mining sites and mining exploration concessions[5] overlap with each other and with the region's protected areas and agro-forestry zones (Tieguhong 2009). Similar potential conflicts in land use have been noted in many places and are normal practice in almost every country of the Congo Basin. This scenario carries with it the potential for large-scale deforestation and forest degradation should land allocation proceed according to these conflicting administrative decisions.

IMPACTS OF ARTISANAL AND SMALL-SCALE MINING

Direct Impacts

The environmental damage from ASM can sometimes be greater than that from large-scale mining. Opencast and surface-pit mining, which are mostly seen in Central Africa, have a direct impact, especially in densely forested areas. Poor site management is a particular concern in areas where ASM predominates.

[5] It is important to note that in most cases these are exploration concessions, not mining concessions, and that a large number of exploration sites never turn into operational mines. The mining legislation in all countries in the Congo Basin, perhaps with the exception of the Democratic Republic of Congo, allows for exploration activities in protected areas. However, a mining exploitation permit would require degazettementof a protected area.

The environmental impacts on the forest will vary according to mining techniques, the governance situation, and whether it is a "historical" mine site or a "mine rush" (a feverish migration of workers to an area that has had a dramatic discovery of mineral deposits), and whether it occurs in intact or already disrupted ecosystems.

The amount of ASM-induced deforestation can be small relative to the impact of other illicit activities, such as logging, subsistence farming, or charcoal production. A study of ASM in the Sangha Tri-National Park area of Cameroon, the Central African Republic, and the Republic of Congo found little environmental impact from small-scale mining in that region. Negative impacts from mining accrued mainly to local rivers (for example, erosion, siltation, diversion of streams) and were temporal (Tieguhong 2009). However, miners in this area operate with very rudimentary technologies and do not use mercury or cyanide to process the ores extracted. In addition, the relatively low numbers of artisanal miners have limited the impact to forests and rivers.

When ASM takes place in a forest environment, trees are removed for tunneling and pit mining, and to access minerals located beneath the flora. Timber is used to construct wood shaft support, for cooking fires, and to generate heat to crack rocks in underground workings. The repeated soil turnover and complete removal of roots that accompany mining impede regeneration and favor invasive species. Most artisanal and small-scale miners lack the capital or knowledge to preserve topsoil and vegetation, preferring to wash it away with high-pressure hydraulic hoses. The environmental impact of such practices can be severe and long-lasting. For example, sedimentation from artisanal and small-scale gold mining has caused structural changes in fish taxonomic structure in the Guiana Shield, which is evident even in nonmechanized artisanal operations (Miranda and Blanco-Uribe 1998).

An increase in the number of miners, use of semi-mechanized or mechanized methods, and incorporation of chemical processing (in the case of gold) can result in a much greater negative impact to forest landscapes. This is particularly the case for rush situations, when many people suddenly invade a site in the hope of finding precious metals, without any control or accountability. A study using satellite imagery found that deforestation in eastern Congo coincided with small-scale gold and cassiterite mining (IES 2008).

The use of chemicals in ASM is leading to massive release of liquid elemental mercury into the environment, with severe environmental consequences. In central and southeastern Democratic Republic of Congo, small-scale miners discharge hazardous waste directly into rivers and lakes, and high levels of mercury and uranium have been found in mine tailings. Concentrations of toxic heavy metals such as cadmium, zinc, and lead have been found to exceed international standards by a factor of 2 to 10. In the Amazon Basin, about 63 percent of mercury concentrations found in the atmosphere has been linked to gold mining (Telmer 2009).

Indirect Impacts

The additional economic activities triggered by ASM rushes on previously non- or sparsely inhabited areas are often far more damaging than the mining activity itself. Mining in and at the edges of forest enhances the risk of access as the open access paradigm applied by miners is adopted by local villagers in search of land to grow crops. In addition, the establishment of mining villages in dense forest areas (like in the Minkebe mining camp in Gabon) leads to deforestation for cooking and construction.

If mining takes place in relatively pristine areas with high biodiversity, there will be many animals and therefore opportunities to hunt, either for subsistence or—far more damaging—commercially. A large influx of miners can lead to heavy disruption of local wildlife, especially vulnerable species that are found only in remote forest areas. The logistical chain supplying the artisanal gold miners can also be used for bushmeat and ivory transport. Experience shows that it is not necessarily the miners themselves who hunt. Miners might be supplied by bushmeat hunters, or bushmeat/ivory hunters might use mining camps and mining trails as "infrastructure" to cover vast areas of forest looking for ivory. Thus, the presence of artisanal mining camps in previously inaccessible areas allows other activities and networks to develop, such as the trade in illegal wildlife products, notably ivory.

Much depends on the scale of an artisanal mining site. Large-scale artisanal mining camps attract the interest of local authorities and often, in due course, become legalized as officially recognized villages. Thus, a temporary artisanal mining camp in a remote area can become a permanent settlement with a school, an officially recognized village head, and so on, leading to a long-term—possibly permanent—impact on the wider forest. This has been the case in uninhabited areas such as many parts of the TRIDOM Interzone.

Cumulative Impacts

While individual artisanal mining sites may have fairly small and localized impacts on vegetation, wildlife, and habitats, the cumulative impacts of hundreds of artisanal mining sites around the country can lead to increased risk of deforestation, habitat conversion, and loss of biodiversity.

The below table 3.2 summarizes the potential impacts of ASM activities.

CONFLICT MINERALS

In talking of mining in the Congo Basin, it is impossible to avoid the issue of conflict minerals. Armed conflicts and associated extractive activities, including mining activities, can lead to major pressures on natural forests and habitats. The link between mining and armed conflict has been well documented, especially in the Democratic Republic of Congo. Reports by the United Nations and several national and international nongovernmental organizations (NGOs) have shown that natural resources were, and still are, fueling conflict in eastern Democratic Republic of Congo. Rebel groups and members of the Congolese National Army control the exploitation of gold, cassiterite, coltan, wolfram, timber, and diamonds in a number of areas in North and South Kivu. They have become "informal owners" of pits, and they are levying taxes on minerals trade. In some territories in eastern Congo, the informal artisanal mining sector generates hundreds of thousands of informal jobs and tens of millions of dollars a year.

The illegal exploitation of minerals often goes hand in hand with other illegal activities, such as the trade in ivory and other wildlife products. As indicated by the dire situation of protected wildlife and plant/tree species in eastern the Democratic Republic of Congo, conservation efforts are severely affected by the de facto failing state situation and the environmental impacts of uncontrolled artisanal mining of minerals that is controlled by rebel groups and criminal networks. The minerals are believed to be a driver of the

Table 3.2: Environmental Impacts of Artisanal Mining

ASM activity	Observed or anticipated ecological impact
Logging and foraging for household subsistence and mining activities, such as– • Timber and branches to build camps to accommodate workers, reinforce mineshafts, or make mining tools and carrying baskets) • Forest clearance to expose substrate for mining • Firewood for warmth and cooking in camps • Bark to make pans for washing minerals • Cutting specific plants to make carrying baskets for minerals or using plants for medicine in the mining camps	• Habitat loss • Habitat is blocked by mine camps • Deforestation and its impact on dependent species • Clearing of forests makes them more susceptible to invasive species • Erosion of unprotected earth during rains leads to landslides • Soil degradation (also see siltation and its impacts, below) • Cleared spaces can act as sites for congregation of elephants
Physical removal of earth and rock to access the mineralized deposit • Use of high-power hoses or medium and large size backhoes and dredges to remove topsoil or the top layer of sand and clay	• Release and dispersal of corrosive dusts (such as lime dust and, in particular, quicklime) that can detrimentally affect soils, vegetation, and human health
Mining riverbeds, riverbanks, and streams • Pollution of streams by silt from washing process • Diversion of rivers to access mineralized deposits in the riverbed • Direct dumping of waste, tailings, and effluents in waterways • Removal/disruption of riverbeds and riverbanks by intensive scooping, dredging, or vacuuming • Digging in riverbanks • Unmanaged release of tailings into waterways	• Siltation reduces light penetration into water bodies, causing reduced photosynthesis in aquatic plants and depleting oxygen levels in the water. It often clogs the gills of fish. Both consequences kill aquatic life. • Reduced productivity of fish stocks in lakes and rivers affected by silt pollution • Erosion of unprotected earth during rains, leading to landslips and sediment-heavy water • Destruction of aquatic habitat affects species viability and thus biodiversity. • Reconfiguration of hydrological systems manually in one area (for example, rivers are widened by dredges) leads to natural reconfiguration downstream (such as transmission and storage capacities of rivers and dams) owing to sedimentation. • Deposits of debris lead to blocked or rerouted waterways, disappearance of marshland and wild bird habitats, and increased risk of flash floods. • Pollution of drinking water • If siltation and pollution are severe, they may make the water undrinkable for wildlife, potentially altering grazing patterns and traditionally inhabited locations.
Lack of backfilling when digging pits in search of gold or other minerals	• Stagnant pools of water in mining pits are breeding grounds for malaria-carrying mosquitoes and water-borne diseases. • Abandoned pits pose a risk of injury and drowning to children and animals. • Previously mined sites are often unusable for agriculture, forcing people into other habitats to serve their needs.
Use of toxic chemicals in gold processing Use of cyanide Use of mercury, especially vaporization and release into the waterways	• Risk of dead zones and localized death of animals (including birds and fish) exposed to unmanaged cyanide releases • Fish and animal health affected by mercury in air or water • Bioaccumulation of Hg up the food chain, especially in fish (including ocean species such as shark, marlin, tuna) consumed by local and distant populations • Pollution of human drinking water

(continued on next page)

Table 3.2: Environmental Impacts of Artisanal Mining *(continued)*

Ancillary/support services	
Heavy hunting of animals for bushmeat to feed miners and camp followers	• Population decline of critically threatened and endangered species owing to hunting • Animals maimed or dying after escaping from snares • Disturbance of wildlife habitats and migration routes owing to large number of people living in and moving through forest, as well as light and sound pollution from mining activities • Population decline of poached species, affecting the food web and biodiversity
Poaching of animals for commercial bushmeat, wildlife trade, and other products for sale (for example, ivory)	• Widespread wildlife degradation in the last wildlife strongholds that remain in Africa • Exposure of gorillas and chimpanzees to disease owing to sewage from mining sites • Exposure of humans to disease owing to increased animal interaction • Increased human-wildlife conflict—greater population density in the park means more human encounters with animals
Establishment of permanent and semi-permanent camps, villages and towns	Abundance and behavior of wildlife is disturbed due to road networks Lack of household waste management • Ground, soil, water, air pollution • Spread of disease in humans, such as cholera and typhoid Large radius hallo effect in terms of hunting radius thus affecting wildlife populations over large areas.
Larger ecosystem impacts	
• Ecological changes owing to loss of key species such as elephants and apes • Long-term changes in watershed owing to rapid runoff in deforested areas • Downstream hydrological impacts with respect to water quality and flow as a result of widespread siltation and pollution of rivers and streams • Change in settlement patterns and consequent long-term impact on the last intact forest ecosystems	

Source: Villegas 2012.

ongoing lawlessness in key conservation zones, leading to unprecedented depletion of biodiversity.

Increased interest on the part of electronics and jewelry companies in mapping the supply chain of their primary minerals has created pressure to address the problem of conflict minerals. On August 22, 2012, the U.S. Securities and Exchange Commission (SEC) adopted a rule mandated by the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 to require companies to publicly disclose their use of conflict minerals that originate in the Democratic Republic of Congo or an adjoining country. Many other initiatives have been developed focused on methodology for due diligence against conflict minerals; for example, the OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas (December 2010). The International Conference of the Great Lakes Region (ICGLR) launched a Regional Initiative on Natural Resources that promotes dialogue among ICGLR member states on issues related to the illegal exploitation of natural resources and provides them with tools to break the link between armed conflict and revenues from natural resources (Global Witness 2011; ICG 2012).

While much of the conflict minerals narrative focuses on human rights concerns, an overlooked issue is that this mining is taking place in the heart of two of the most important ecosystems on earth: the Congo Basin and the Albertine Rift. In creating these supply chain assurance systems, it seems shortsighted to overlook safeguards to protect ecological resilience. Efforts to manage today's armed conflicts may be creating conditions that will make tomorrow's conflicts more probable, such as sowing the seeds of resource scarcity conflicts (Levin 2012).

CHAPTER 4

Policy Recommendations

The Congo Basin is home to a vast wealth of diverse mineral resources. The value of these minerals on world markets is worth billions of dollars, but their potential remains largely untapped. The rise of world prices for many minerals has led to an increased interest in mining in the subregion, which will inevitably have a negative impact on the unique forest ecosystems. The recommendations that follow aim to help policymakers and donors promote practices to reconcile mining development and forest wealth in the critical forest ecosystems of the Congo Basin.

Promote Integrated Land Use Planning for Mining and Associated Infrastructure Development

Indirect impacts associated with mining operations and associated infrastructure development can constitute a major threat to forests. An appropriate land use planning exercise that identifies the most promising corridors (for mining as well as other commodities) and the appropriate mix of transportation modes (roads, railway, rivers) can help reduce the effects of mining activities on forests.

Land use planning is a tool to organize multiple demands for land while minimizing the likelihood of competition and conflict. The main objective is to prioritize economic activities in a specific territory while at the same time ensuring the sustainable use or conservation of natural resources. All the Congo Basin countries suffer from a lack of land use planning and intersectoral coordination to ensure sustainable development at the local and national levels. As a result, numerous conflicts have arisen between and among conservation priorities, mining and logging concessions, infrastructure development projects, agro-industry, and the livelihoods of the local populations.

A comprehensive land use planning exercise should help define the land uses that will be pursued on the national territories. Implementing land use planning is not easy, and it is very unpredictable because of commodity price fluctuations, changing government priorities, and so on. This type of exercise requires strong coordination among the various line ministries and arbitrage at the highest levels to reconcile potentially conflicting uses. In addition, trade-offs among different sectors and within sectors must be clearly understood by the stakeholders, so they can define robust development strategies at the national level.

The first step in a comprehensive land use planning exercise will be a diagnosis of current land uses and the primary limitations and opportunities, such as potential mining sites, transportation corridors, and areas of high biodiversity. This will require the collection and analysis of a substantial amount of information (including geological information), as well as significant interinstitutional collaboration and transparency. It will also require strong political commitment and sufficient technical and financial resources. Using this information, different land use scenarios can be developed, taking into account social, ecological, and economic considerations in an inclusive and participative manner. Some interesting lessons can be learned from similar exercises in resource-rich countries in Latin America (ELLA 2011).

One output of such an exercise could be the identification of major regional development corridors and

Box 4–1: Mining and Biodiversity: Not an Impossible Marriage

Mining does not necessarily lead to biodiversity loss if adequate safeguards are in place to deter workers from hunting; road building is kept to a minimum; road access is strictly controlled; and new settlement/immigration along these roads is not allowed. After the useful life of the mine, the road access should be destroyed or, at the very least, a control system should remain in place. Laurance (2008b) survey of the impacts of roads, hunting, and habitat alteration on nocturnal mammals in southern Gabon used the Shell-managed Rabi oil concession as the study's control condition. The company uses a fly-in/fly-out (FIFO) model for its operations in Rabi; it strictly controls access to the concession, and guards are posted at each access point. Workers are forbidden to hunt and are not permitted to leave their camps after nightfall. As a result of these and other measures, approximately 90 percent of the original forest cover within the concession remains intact, and wildlife populations have been well preserved.

On the other hand, Shell's oil exploitation led to the development of the town of Gamba (population 9,000) in a previously very remote area which is the now center of increased disruption (and additional road building to access Gamba), leading to a larger impact than one sees by looking only at the Rabi concession.

Reactions have been mixed to the use of FIFO in resource development in remote areas. The model has been criticized for not contributing to the economic development of the rural areas from which the resources are taken. The lack of project-community interaction can lead to a fly-over effect, in which most of the benefits of resource development accrue to the large urban centers (Storey 2010). Proponents argue that a residential workforce can have high social costs, including the development of a large transient population.

So far, few mining companies have adopted FIFO as a workforce option to minimize the mine footprint on the environment; the Rabi example is fairly unique. Further research is needed on the opportunity costs and benefits for mining companies to adopt FIFO, as well as the trade-off with local economic development. Such research could study the use of a residential workforce by timber logging companies in the region.

growth poles that could be developed in a coordinated manner to optimize resource and land use. The Economic and Monetary Community of Central Africa (CEMAC) identified the mining sector as a regional priority, because much of the mining-related infrastructure will have to be cross-border. For example, the Mbalam-Nabeba iron project, on two sides of the border between Cameroon and the Republic of Congo, will require infrastructure development (a railway line, a deepwater port, a processing unit, and potentially a hydroelectric power dam) in two countries. It will need an integrated land use process that takes into account cross-border economic, social, and ecological considerations. The Economic Community of Central African States (ECCAS) has adopted the corridor approach at the regional level to foster synergies and economies of scale among member states.

Set High Standard Goals for Environmental and Social Management

So far, mining activities have had limited impacts on Congo Basin forests, because the majority of the mining operations have occurred in nonforested areas; however, expanded mining activities will increasingly affect the forest. If mining is to result in minimal negative impacts to the forests of the Congo Basin, companies will have to follow best international practices and standards designed to comply with the mitigation hierarchy (avoid, minimize, restore, compensate).

International standards for responsible mining have been developed by various (sometimes competing) organizations, including the International Council on Mining and Metals, the Responsible Jewelry Council, the International Finance Corporation, and the Initiative for Responsible Mining Assurance. These initiatives address large-scale mining; the corollary for the small-scale mining sector is the Alliance for Responsible Mining (ARM). ARM has developed a certification system for small-scale mining cooperatives that considers both environmental and social concerns. In addition, some oil and gas companies (for example, Shell Oil) have developed extractive projects that seek to minimize the impact of extraction on forests in Basin countries. Lessons can be learned from these innovative approaches as the governments adjust their national regulations on mining activities and their environmental monitoring and management.

However, different standards have been created to achieve different sets of objectives or to address perceived gaps. Often this has not been done in a truly inclusive, multistakeholder way, incorporating all the issues, which has led to competing standards. Standards should be evaluated on what they set out to achieve. Given the differing expectations of various stakeholder groups, a combination of standards should probably be employed to address the most common concerns. Some sense of harmonization is slowly emerging, with increasing cross-referencing among standards.

A challenge for any company—especially for many of the junior mining companies operating in the Congo Basin—is to make sense of the growing number of standards and best practice guidance initiatives that various stakeholders may expect it to implement. There is no globally agreed upon standard or set of standards that all stakeholders believe adequately covers the many issues involved in the search for responsible mining and the ultimate closure of mines (Levin 2011).

In addition to international standards that could be applied to mining activities in the Congo Basin, national standards must be properly defined and enforced. Environmental impact assessments (EIAs) and social impact assessments (SIAs) must be prepared for all stages, and management plans must be created to mitigate risks. In many countries, EIAs/SIAs are required by law.[6] However, very often these assessments do not meet minimum quality standards. Beyond weaknesses in the assessments, the mitigation plans are often poorly designed and difficult to implement and monitor. Several countries in the Congo Basin have undertaken (Gabon) or are in the process of starting (Cameroon and the Democratic Republic of Congo) strategic environmental and social assessments (SESAs) of their mining sectors. A SESA is a tool to enhance the environmental and social sustainability of mining sector reform. It engages multiple stakeholders in a dialogue to inform and influence policymaking. If it is well implemented, a SESA can be the catalyst for increased attention to environmental and social priorities associated with mining development; strengthened environmental constituencies; improved social accountability (by making the mining policy process more transparent); enhanced sector capacity for managing environmental and sociopolitical risks associated with mining sector development; and the capacity to consider alternatives to mining when appropriate. The SESA report is just the start of a process. Governments should not only focus on the development of SESA recommendations but commit to maintaining a multi-stakeholder dialogue, so that economic, social, and environmental/conservation needs and concerns are heard and acted upon on a permanent basis .

6 The exploration phase is generally not covered by EIAs in Congo Basin countries, even though significant impacts can occur at this stage.

Improve Management of the Artisanal and Small-Scale Mining Sector in Areas of High Biodiversity

In many cases, the impacts of artisanal mining activities—though scattered and more difficult to assess and monitor—are expected to be significant, especially the cumulative effects over time. In some countries, hot spots of deforestation are clearly linked to small-scale mining activities.

Efforts should be focused on organizing small-scale miners and applying regulatory frameworks, including enforcement of no-go zones for mining. The specific rights and duties of artisanal miners should also be addressed, including long-term security of tenure, and realistic environmental and safety requirements should be instituted. Artisanal mining activities should be taken into account in land use planning processes. Improving

Box 4–2: Good Practices for Social and Environmental Management of the Mining Sector

Footprint. Mining can have a large environmental and social footprint; good practice involves not only minimizing, managing, and mitigating environmental and social risks but also optimizing the potential benefits for people and the environment. It is good practice to manage environmental and social impacts together, as they are closely related. Given the nature of the risks, management of potential adverse impacts is accomplished through requirements that are legally binding, with penalties for noncompliance.

Oversight. Good practice requires a developed governance system for oversight, which could take various forms. It could be a prescriptive/audited approach, which would work well with smaller, less sophisticated companies. Or, in countries with more capacity, the legal requirements could be complemented by placing more responsibility on the operator to work with a codes of conduct developed by the operator and agreed to by the authorities. Both systems would require capacity within the authority to manage the workload.

Compliance standards. Good practice is for compliance standards to be achievable and to align with international practice. If they are unrealistically strict, they could become meaningless given the capacity limitations in most countries; but if they are too lax, even good enforcement will not accomplish much. Good practice is first to make sure compliance standards are appropriate and then to ensure the capacity to implement them. In this area, small-scale mining operations will require special attention to adequately reflect the characteristics of this segment of the mining sector.

Environmental and social requirements at all stage of mining operations. Impacts can occur at any stage of mining operations, from exploration to mine closure. Proper EIAs/SIAs must be prepared for all stages, as well as management plans to mitigate the associated risks. A full-fledged EIA is not generally required for exploration activities; however, good practice is to require an initial EIA (similar to a scoping study) for these activities.

The quality of EIAs/SIAs. In many countries, EIAs/SIAs are required by law; however, very often these assessments do not meet the minimum quality standard. Beyond weaknesses in the assessments themselves, the associated mitigation plans are often poorly designed and difficult to implement and monitor. It is important that the EIAs encompass the full range of environmental/social risks associated with the project. The various baseline data, impact assessments,

(continued on next page)

the capacity of government to effectively regulate the sector will be essential.

For ASM in protected areas and sensitive ecosystems that have not been declared off limits for mining, governments should facilitate the use of environmentally friendly technologies, such as retorts and other mercury-capturing devices, and mindful, conservation-minded mining strategies early on in planning processes. Market-based interventions and sustainable supply chain initiatives centered on specific sites can achieve positive social and environmental outcomes by capacity building throughout the supply chain and by the use of standards and certification to ensure ethical performance (Villegas 2012).

Offset Negative Impacts of Mining Operations

A widely recognized approach to integrating conservation concerns into mining is to apply the *mitigation hierarchy* developed by the Business and Biodiversity Offsets Programme (BBOP). This hierarchy sets out a series of best practice approaches to avoid adverse impacts emanating from a mining venture. The best option is to maximize impact avoidance, followed in turn by minimization, restoration, and offsets. These are defined as follows (BBOP 2012):

- *Avoidance:* Measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure,

Box 4–2: Good Practices for Social and Environmental Management of the Mining Sector *(continued)*

and management plans and facilities need to be prepared, not only for the mine site itself and associated waste dumps, water storage, tailings impoundments, stockpiles, and processing plants but also for any infrastructure associated with the mine development, including roads, railway routes, waterways, and ports along which hazardous materials may be transported and locations where they are stored.

Stakeholder consultation. Good practice is that all key documents submitted to the government for approval are also made available to communities in the local language. Where communities are largely illiterate, meetings should be held to present the documents and findings verbally, especially to the poorest and most vulnerable segments of communities. Innovative forms of participative planning—such as participative cartography and dialogue—should be used where possible for land use consultations.

Community hearings. Good practice is that all data collection, impact assessments, and management plans are subject to community hearings open to the public as part of the approval process. Final approved documents should be provided to communities.

Grievances and disputes. While much attention is given to broad community support at project approval, project implementation and operation often receive less attention. Good practice is to ensure the existence of easily accessible and affordable environmental/social grievance or dispute resolution mechanisms that address the needs of the community and give an effective voice to the poorest and most vulnerable.

Conservation NGOs. For mining development in high-quality ecosystems, the conservation NGOs that operate in these countries should be consulted. They often have good terrain knowledge and can help plan for the larger environmental impact, such as bushmeat hunting or new settlement creation, and can help design offset or mitigation mechanisms.

Monitoring and oversight capacities. Corporate compliance with best international standards must be monitored by regulatory agencies. This may be especially challenging in Central African countries, where lack of capacity, inaccessibility of proposed mine sites, governance issues, and security risks make monitoring by regulators difficult at best.

Source: Based on Strongman 2010.

to completely avoid impacts on certain components of biodiversity.

- *Minimization:* Measures taken to reduce the duration, intensity, or extent of impacts (including direct, indirect, and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.
- *Rehabilitation/restoration:* Measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided or minimized.
- *Offset:* Measures taken to compensate for any residual adverse impacts that cannot be avoided, minimized, rehabilitated, or restored, to achieve no net loss or a net gain in biodiversity. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, or protecting areas where there is imminent or projected loss of biodiversity.

BBOP approaches are echoed in recognized international standards. The International Finance Corporation (IFC) has integrated offsets into its new Social and Environmental Performance Standards that became effective in January 2012. The IFC defines offsets as measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project

Box 4–3. Biodiversity Offsets

The Business and Biodiversity Offsets Programme (BBOP) consisted of collaborative NGO-company pilot test sites as well as development of guidance and technical papers on the elements of biodiversity offsets. The resulting guidebooks and supplementary materials can be found at http://bbop.forest-trends.org. Pilot case studies are ongoing, and updates are posted on BBOP's website.

Among the positive outcomes of the BBOP project was a declaration of general principles that is meant to guide companies, governments, and NGOs in biodiversity offset design and implementation. These principles, which include stakeholder participation and the need for companies to first follow the mitigation hierarchy, were discussed and endorsed by BBOP's Advisory Committee. The following are the basic concepts behind biodiversity offsets:

- *No net loss:* Biodiversity offsets should, at minimum, result in no net loss of biodiversity from development.
- *Additional conservation outcomes:* Offsets should add biodiversity value beyond what would have occurred without the offset.
- *Adherence to the mitigation hierarchy:* Offsets should only be considered after the mitigation hierarchy has been applied for projected impacts (avoid, reduce, mitigate, and compensate).
- *Limits to what can be offset:* Some biodiversity losses cannot be offset (for example, extinction of an endangered species).
- *Landscape context:* The offset should be designed taking into account landscape and ecosystem values.
- *Stakeholder participation:* Offsets should be undertaken with the full participation of indigenous peoples and local communities.
- *Equity:* Offsets should be designed and implemented taking into consideration the rights of indigenous and local communities, and respecting local and customary practices.
- *Long-term outcomes:* Offsets should be designed to be sustainable and viable in the long term.
- *Transparency:* Design and implementation of an offset should be undertaken in a transparent manner.
- *Science and traditional knowledge:* Offsets should be designed using the best available science and should take into consideration traditional knowledge.

A multi-stakeholder process has resulted in the development of principles to guide the development of effective offsets. Recently, BBOP launched version 1 of a standard to guide successful design and implementation of offsets. The standard notes that offsets are growing in popularity and lists a number of advantages. It attempts to develop an approach that guarantees that offsets are properly designed to deliver no net loss.

Source: BBOP 2012.

development and persisting after appropriate avoidance, minimization and restoration measures have been taken (IFC 2012). Where there are impacts on natural habitats, companies are required to ensure no net loss where feasible and a net gain when those impacts affect critical habitats. In the Congo Basin, Gabon is considering the development of a system of biodiversity credits based on the concept of achieving no net loss of biodiversity. As a result, more and more mining companies are investigating the possibility of offsetting losses of biodiversity from their mining operations with conservation projects.

However, reliance on offsets to protect biodiversity is a risky approach. Offsets are an emerging mechanism, and few studies have been conducted to systematically assess their success or failure. Some critics have argued that offset programs have actually been counterproductive because they encourage government agencies to grant development permits too easily, ultimately resulting in biodiversity decline. However, in some developing countries, in particular Madagascar, offsets have been successful in promoting habitat protection and involving the participation of companies and private landowners in the conservation of biodiversity. In most developing countries, offset programs are a very recent phenomenon, making it difficult to gauge their effectiveness.

Considering the scale of expected mining activities in the Congo Basin, offsets may be the only mechanism that can prevent a net loss of biodiversity in the region. A significant amount of work remains to be done to put theory into practice and to assess the relevant methodologies and the capacity needed to assess, measure, and monitor impacts and mitigation measures for mining projects in the Congo Basin. Ideally, an appropriate methodology will be identified that can be used at the landscape level to measure losses and gains, so that residual effects from mining operations will be taken into account, measured, and offset.

Promote Innovative Mechanisms to Offset Negative Impacts

Along with mine closure arrangements, good practice is to have one or more financial assurance mechanisms in place to ensure the necessary funding for physical reclamation work once production ceases and revenue stops. Such mechanisms can include cash held in trust, bonds, and certificates of guarantee; letters of credit; securities; or deeds and assignments.

- *Amount of assurance:* Good practice is for the value to be built up progressively over time so that sufficient funds are available at the time of closure, and for the funds to be tax deductible at the time they are irrevocably committed. The amount of funding required would be updated and approved each time the mine closure plan was updated, and the financial assurance provision adjusted accordingly.
- *Cash:* If cash or comparable financial instruments are used, it is good practice for them to be held by an independent trustee that is satisfactory to both the government and the license holder, and to be held in a safe but income-bearing form in a stable currency, so that value is preserved and increases over time.
- *Warranties:* Good practice is for the government to obtain both closure-related warranties that the closure will be completed subject to government requirements and approval and postclosure warranties that the company will remain legally responsible for any environmental risk that persists (such as acid mine drainage) or emerge (such as slope stability of impoundments), and that such risks will be corrected by the company even after the license is handed back.

Strengthen Governments' Capacities to Manage the Mining Sector

Extractive industries sectors present critical policy challenges. Associated revenues are characterized by volatility, uncertainty, exhaustibility, and the fact that investment and technology often originate from abroad—all of these factors challenge policymakers in developing countries. In addition, mining development requires a strategic and comprehensive approach to lastingly translate wealth from the extractive industries into growth and development.

The Extractive Industries Transparency Initiative (EITI) seeks to help resource-rich countries maximize the development gains from the exploitation of their oil, gas, and mineral resources by encouraging greater EI revenue transparency. With its focus on verification and publication of company payments and government revenues from the extractive industries, EITI helps safeguard against corruption and demonstrates how voluntary global standards can help create incentives for transparent actions by governments and industry and provide an objective around which reformers can rally.

However, many stakeholders, including governments, believe that transparent revenue reporting, while important, is not enough. Effective management of oil, gas, and mining resources requires attention along the entire value chain, from granting access to the resources, to monitoring operations, to collecting taxes, to improving economic management decisions, to spending resources effectively for sustainable growth and concrete poverty reduction outcomes.

An EI value chain approach encourages countries to take a strategic and comprehensive view of how to translate wealth from the extractive industries into growth and development. Implementing the EI value chain approach means that a government has (or is interested in developing) a vision for the good governance and sound management of its extractives sector and a rolling program of policy actions, institutional capacity strengthening, and investments consistent with this vision. The program, framed against the value chain, must be prioritized, sequenced, and tailored to country circumstances. Taking into account the impact of mining development on biodiversity—and especially deforestation and forest degradation—should be part of the decision making and management process along every step of the way.

Conclusion and Outlook

The mineral wealth of the Congo Basin countries is exceptional and is unlikely to remain untapped in the context of exploding international demand. Mines promise jobs, infrastructure, and new revenue for the region's development; however, if mining activities are not properly managed, they could also come at a very high environmental and social cost. The main challenge the Congo Basin countries face is to materialize their huge mineral potential without jeopardizing their unique forest capital.

Congo Basin countries are at a crossroads. Most mining activities in the Congo Basin forests are still in the exploratory stage. No major work has been initiated. Congo Basin countries are thus not locked into a mining scheme that would necessarily come at a high cost to forests. Best practices and international standards exist to help mineral-rich countries develop their mining sectors in an environmentally friendly way.

New environmental finance mechanisms could accompany the mining developments in the Congo Basin. Environmental finance includes climate funding for adaptation and mitigation efforts in general (and REDD+ in particular), as well as financing for biodiversity, wetlands, and soil restoration. However, the conditions and scale of eventual REDD+ financing remain uncertain. It is not clear how results-based financing will be measured, what the criteria for payments will be, or how much funding will be available. So far, these issues have not been clarified by international negotiations, nor have the rules that will guide the establishment of national reference levels or reference emissions levels that would allow fully measured results-based financing.

No-regrets measures should yield benefits regardless of the shape and volume of a future REDD+ mechanism under the United Nations Framework on Climate Change. No-regrets measures exist and could be adjusted to a specific country context, to create enabling conditions for the development of a forest-friendly mining sector at the national and regional level. This paper has outlined a number of no-regrets actions.

REFERENCES

BBOP (Business and Biodiversity Offsets Programme). 2012. *Business and Biodiversity Offsets Standards*. Retrieved from http://bbop.forest-trends.org/: http:/www.forest-trends.org/documents/files/doc_3078.pdf.BRGM (Bureau de Recherches Géologiques et Minières), 2004. Geological Map of the Congo Basin and Its Surroundings. Colloque on *Geoscientific Infrastructure in Africa for Sustainable Development*. June 2–7, 2004. Orleans, France

ELLA (Evidence and Lessons from Latin America). 2011. "Land Use Planning for Extractive Industries." Policy Brief, ELLA, Economic Development, Extractive Industries and Land use.

ETC-RWM (European Topic Center on Resource and Waste Management). 2005. *Iron and Steel: A Materials System Analysis.* Copenhagen: ETC-RWM.

Financial Times. 2011, September 20. Retrieved from www.ft.com/intl/cms/s/0/d924ca88-e3a2-11e0-8990–00144feabdc0.html#axzz2DMl1jgZr.

Global Witness. 2011. *Congo's Mineral Trade in the Balance: Opportunities and Obstacles to Demilitarization.* London: Global Witness.

Hollestelle, M. 2012. "Gabon Case Study Report: A Situational Analysis of ASM in Protected Areas and Critical Ecosystems; and Recommendations for Gabonese Policymakers to Attain Ecologically and Socio-Economically Responsive Artisanal and Small-Scale Mining." Retrieved from www.asm-pace.org.

IBI International. 2009. *Secteur Minier Gabonais: Etude Strategique Sociale et Environnementale.* Arlington, USA.

IES (Institute for Environmental Security). 2008. *Mining, Forest Change and Conflict in the Kivus,Outcome of a Short Study within the IES-ESPA Programme.* Wageningen, Netherlands: IES.

ICG (International Crisis Group). 2012, September. *Conflict Minerals in the DRC*. Retrieved from www.crisisgroup.org: http://www.crisisgroup.org/en/publication-type/key-issues/country/conflict-minerals-in-drc.aspx.

IFC (International Finance Corporation). 2012, September. IFC Performance Standards on Environmental and Social Sustainability.Washington, DC.

Jaques, E. 2001. La mine artisanale en Afrique : aspects techniques et environnementaux. *Séminaire sur l'exploitation minière artisanale en Afrique, 01.03/12/2000* (pp. 87–93). Occasional CIFEG Publication 2001/37, Ouagadougou, Burkina Faso.

Javelle, A.G.. 2012. *Managing Land for Mining and Conservation in the DRC.* Washington DC: Africa Biodiversity Collaborative Group.

Lahm, S. C. 2002. *Counting and Recounting in Northern Gabon.*

Loayza, F., Albarracin-Jordan, J. .2010 *Mining Sector Strategic Environmental and Social Assessment, Environment Notes.* Washington, DC: World Bank.

Laurance, W. C. 2008a. "Impacts of Roads and Hunting on Central African Rainforest Mammals," *Conservation Biology* 20 (4): 1251–1261.

Laurance, W. C. 2008b. "Impacts of Roads, Hunting and Habitat Alteration on Nocturnal Mammals in African Rainforests," *Conservation Biology*, 22 (3): 721–732.

Levin, E. 2010. *Property Rights and the Artisanal Diamond Development Project (PRADD)Comparative Study: Legal and Fiscal Regimes for Artisanal Diamond Mining.* Washington, DC: U.S. Agency for International Development.

Levin, E.. 2011. *Benchmark Study of Environmental and Social Standards in Industrialised Precious Metals Mining.* Amsterdam: Solidaridad.

Levin, E.. 2012. *Greening ICT supply Chains—Survey on Conflict Minerals Due Diligence Initiatives.* London, UK.

MEG (Metals Economics Group). 2012. *World Exploration Trends 2012: A Special Report from Metals Economics Group for the PDAC international convention.* Halifax: PDAC. Retrieved from http://www.metalseconomics.com/sites/default/files/uploads/PDFs/wet2012english.pdf.

Miranda, M., et al. 2003. *Mining and Critical Ecosystems: Mapping the Risks*. Washington, DC: World Resources Institute.

Miranda, M.,, Blanco-Uribe A.,. 1998. *All That Glitters Is Not Gold - Balancing Conservation and Development in Venezuela's Frontier Forests.* World Resources Institute (WRI)Washington, DC:

Nguiffo, H. S. 2012. *Emerging Trends in Land-Use Conflicts in Cameroon: Overlapping Natural Resource Permits Threaten Protected Areas and Foreign Direct Investment.* Yaounde, Cameroon: World Wildlife Fund, Cameroon Environment and Developement.

Parrotta, J. 2001. "Restoring Tropical Forests on Lands Mined for Bauxite: Examples from the Brazilian Amazon," *Ecological Engineering* 17 (2,3): 219–239.

Parrotta, J. K. 1997. "Development of Floristic Diversity in 10-year-old Restoration Forests on a Bauxite Mined Site in Amazonia," *Forest Ecology and Management* 99 (1,2): 21.

Pauli, D. B. 2006. "Monitoring the Environmental Impact of Mining in Remote Locations Through Remotely Sensed Data," *Geocarto Interational* 21 (1): 33–42.

PDAC (Prospectors and Developers Association of Canada). 2012, September. "Principles for Responsible Exploration." Retrieved from www.pdac.ca/e3plus.

Reed, E. Miranda. M. 2007. *Assessment of the Mining Sector and Infrastructure Development in the Congo Basin.* World Wildlife Fund, Washington, DC.

Storey, K. 2010. "Fly-in/Fly-out: Implications for Community Sustainability," *Sustainability* 2: 1161–1181.

Strongman, J. 2010. *World Bank Oil, Gas and Mining Policy Division (COCPO)Mining Toolkit: The EI Value Chain.* Preliminary draft. Washington, DC: World Bank.

Telmer, Kevin. 2009. World Emissions of Mercury from Small-Scale and Artisanal Gold Mining. In *Mercury Fate and Transport in the Global Atmosphere: Emissions, Measurements and Models*, ed. CNR-Institute for Atmospheric Pollution. Roma, Italy

Tieguhong, Julius Chupezi. 2009. *Impacts of Artisanal Gold and Diamond Mining on Livelihoods and the Environment in the Sangha Tri-National Park Landscape.* Yaounde, Cameroon: Center for International Forestry Research.

Trading Economics. 2012. Retrieved from www.trading-economics.com/commodity/copper *goldprice.org*.

USGS (United States Geological Survey). 2009. "USGS 2009 Mineral Handbook: Retrieved from http://minerals.usgs.gov/minerals/pubs/commodity/niobium/myb1.2009-niobi.pdf.

_____. 2010. Retrieved from http://minerals.usgs.gov/minerals/pubs/country/2010/myb3–2010-ek.pdf.

_____. 2012. Retrieved from http://minerals.usgs.gov/minerals/pubs/mcs/2012/mcs2012.pdf.

UN Comtrade. 2012. International Merchandise Trade Statistics (IMTS) accessed pm http://comtrade.un.org/ in December 2012. Villegas, L. W. 2012. *Artisanal and Small-scale Mining in Protected Areas and Sensitive Ecosystems: A Global Solutions Study.* Retrieved from www.asm-pace.org..

World Bank. 2008. *Democratic Republic of Congo: Growth with Governance in the Mining Sector, The World Bank Oil, Gas, Mining and Chemicals Department AFCC2 Africa Region Report No. 43402-ZR.* Washington, DC: World Bank.

World Bank. 2011. *PRECASEM Project Appraisal Document to the Republic of Cameroon .* Washington, DC: World Bank.

______. 2012a. *Republic of Congo, Mining Sector Review.* Washington, DC: World Bank.

______. 2012b. Commodity Markets database. Website: http://go.worldbank.org/4ROCCIEQ50, last accessed on December 2012.

World Gold Council. 2012, September. *The Story of Gold*. Retrieved from www.gold.org/about_gold/story_of_gold/demand_and_supply.

Annex

Mining Sector in the Congo Basin – Country Profiles

Each country of the Congo Basin has developed specific schemes for the use of its natural resources, especially mineral resources, in response to its distinct political, economic and social characteristics. The following sections provide a short overview of the mining situation in each of the countries of the Congo Basin.

CAMEROON

Cameroon has strong geological potential for a number of minerals: the country has large deposits of iron ore and bauxite, plus moderate deposits of gold, diamonds, limestone, cobalt, and nickel, among others. Despite its geological wealth, however, mining has never played a major role in Cameroon's development and has remained on the margins of the economy. Artisanal mining is the basis of community livelihoods in several regions rich in gold or precious stones, but informality prevents this subsector from contributing to growth (World Bank 2011). Cameroon's 2035 Economic Growth and Employment Strategy contains plans for economic diversification and development of a wide array of projects, including large infrastructure investments (ports, dams, roads, etc.), mines, oil/gas projects, and agro-industrial plantations.

Cameroon has significant experience with extractive industries, mainly through timber, oil, and gas. The country has been a relatively small but mature oil producer for several decades, and oil still plays an important role in the economy. In 2009, oil represented about 25 percent of government revenues and 40 percent of export earnings. However, national oil production has been constantly declining and has been criticized for not bringing enough benefits to the people. There are high expectations in Cameroon that mining will replace oil as the dominant source of government revenue.

Efforts to reform the mining sector began in 2001, when the Cameroonian authorities passed a new mining code. The new policy, combined with higher commodity prices, generated some investor interest and brought several large players to Cameroon. The country started issuing exploration licenses (as of 2012, 150 licenses were valid, though many are purely speculative). In 2010, the mining code was amended, modifying a few articles, but the subsequent regulations have not yet been promulgated. As of May 2011, a number of large-scale projects were in advanced stages of exploration: the iron ore project near Mbalam (CamIron), the nickel-cobalt project near Lomié (Geovic), the diamond mine near Yokadouma (C&K mining), and the bauxite development near Ngaoundere (CAL). It has been estimated that somewhere between 10,000 and 30,000 artisanal miners extract primarily gold, diamonds, sand, and gravel in Cameroon's eastern and southern regions. Additionally, more than 30 companies run small-scale mechanized mining operations in the east. Cameroon's ASM sector is highly unregulated, despite its significant localized impacts on the forests and hydrology.

Despite encouraging signs, the country still lacks the necessary mechanisms to take full advantage of its mineral endowment. The legal framework, management capacity, governance, and coordination in the mining sector need to be improved to provide an enabling environment for long-term investments and to allow the sector to resist economic and political cycles. The revenues generated by the exploitation of mineral resources will benefit the country and the population only if sector management, accountability, and transparency improve.

Like all other countries in the Congo Basin, Cameroon is facing potential land use conflicts among mining, agriculture, forestry, and conservation. With unclear laws and about 20 percent of the territory subject to valid mineral research licenses, the country is already facing several conflicts (Nguiffo 2012). This situation is largely the result of inconsistent levels of transparency and coordination across the natural resource sectors and the lack of a consistent framework for the attribution and publication of natural resource permits and contracts, which would ensure coherence across natural resource sectors (Nguiffo 2012).

Cameroon is considering eliminating the obligation to reclassify an equivalent forest when forest is destroyed in the permanent forest estate. This means that mining, its associated infrastructure, and agro-industry could run wild in the forest and there would be no back-up. If this happens in Cameroon, neighbors will likely follow suit. The possibility is a major threat to the Congo Basin.

DEMOCRATIC REPUBLIC OF CONGO

Mining represents a critical sector for the development of the Democratic Republic of Congo, which is one of the most mineral-rich countries in the world. The Katanga Copper Belt makes it the second richest copper region in the world after Chile. Since the early 1910s, the mining sector has dominated the Congolese economy and served as its engine for growth. For instance, at its peak in the mid-1980s, copper production approached 600,000 tons a year, and the annual contribution of the entire mining sector to GDP was 8 percent to 12 percent. However, as a result of a decade of civil war and conflict during the 1990s and early 2000s, flagship industrial mining declined substantially, and informal, largely undeclared, and uncontrolled production of mineral commodities has taken place throughout the country.

The Democratic Republic of Congo faces huge challenges in leveraging its existing and prospective mineral wealth for sustainable development. Mineral rents were an integral factor in sustaining the Mobutu regime (1965–1997) and the protracted conflict that followed its collapse. The mining sector has been and will continue to be a crucial element of the state's resource base at the national and especially the subnational level (for example, Katanga, Kasais, Kivus). Challenges in developing other economic sectors tend to increase the relative importance of the mining sector, even if it currently operates below its potential. The management of the Democratic Republic of Congo's mineral wealth is central to the maintenance of political stability, but speculation and the exploitation of the mining sector continue to fuel tensions among interest groups. The administration of the sector is dysfunctional, handicapped by insufficient institutional capacity, a poor business climate, and fundamental deficiencies in governance.

The Democratic Republic of Congo is home to 66 million people, of which an estimated 16 percent (approximately 10 million people) derive their livelihoods from artisanal and small-scale mining (ASM). This economic reality has led the World Bank to describe the Democratic Republic of Congo's ASM sector as "the most important segment of the mining sector" (World Bank 2008). A significant proportion of the ASM activity is based in the country's east and overlaps significantly with protected areas and most vulnerable ecosystems, such as the mountains of the Albertine Rift.

As part of its economic reform program since 2001, the government has made some efforts to improve governance of the sector, including the enactment of the 2002 mining code and the partial restructuring of the state-owned copper and cobalt producer GECAMINES in 2003–2004. These efforts led to the resumption of mining production and an increase in foreign direct investment in the sector. These actions, followed by a period of high commodity prices between 2004 and 2008, resulted in a renewal of investment in exploration and exploitation activities in the country, though primarily focused in southern Katanga province. A temporary drop in commodity prices during the global financial crisis of 2008–2009, as well as a controversial process for revisiting mining contracts,[1] led to a deterioration of the investment climate. However, since the strong recovery of commodity prices, private sector investment in new projects has been substantial.

The country is gradually developing a longer term vision but still lacks the necessary mechanisms to take advantage of its mineral endowment. Governance in the mining sector needs to be improved to provide an enabling environment for long-term investments and to allow the sector to survive economic and political cycles. The revenues generated by the exploitation of mineral resources will benefit the country and the population of the Democratic Republic of Congo only if they are accompanied by enhanced sector management, transparency, and accountability.

The return of industrial mining in the Democratic Republic of Congo also revives competition with other kinds of land use, including forestry and conservation interests. A review by conservation organizations of the January 2011 mining cadastre identified 629 mining permits that overlap with protected areas (Javelle 2012, p. 3). The problem of overlapping land use is not restricted to mining concessions and protected areas. Research shows that logging concessions overlap with protected areas, and mining permits overlap with logging concessions and REDD+ projects. The Democratic Republic of Congo's contradictory laws, inconsistent information, and weak intergovernmental coordination create confusion, uncertainty, and misunderstanding for all stakeholders.

REPUBLIC OF CONGO

In the Republic of Congo, approximately two-thirds of national GDP and 80 percent of exports come from oil. The country's current economic performance has resulted from this national wealth that has been successfully exploited for 40 years. Taking into account existing and newly found reserves, a post-oil period is still on the distant horizon, but the heavy reliance on oil poses significant risks for macro-economic balance and stability as well as sustainable development and poverty reduction. The government has set out a diversification strategy that highlights mining as a priority sector, but much remains to be done to improve the investment climate (World Bank 2012).

In recent history, the mining sector in the Republic of Congo has essentially been artisanal: gold, diamonds, and industrial minerals such as salt, sand, and marble. Small industrial production of gold stopped decades ago, but artisanal miners have constantly (mainly informally) produced precious minerals such as gold or diamonds. The Republic of Congo is a relatively small producer of diamonds, but it shares borders with several important regional and global diamond producers. Some industrial minerals (for example, cement) are produced on a limited scale. Production figures of artisanally mined gold, diamonds, and other minerals are scarce and probably inadequate.

Little is known at this stage about the full mineral potential of the Republic of Congo. It is very likely that the potential will be much larger than what is currently known. Existing information shows potential for gold, iron, diamonds, potassium, manganese, phosphate, and tar sands. Since 2005, prospecting and research activities have shown a new dynamism; by the end of 2010, the ministry of mines had allocated 48 prospecting licenses to 28 companies and 49 research permits. Recent developments in the mining sector have demonstrated that one or several significant

1 Many of the state-owned enterprises that entered into partnership agreements with private sector companies during the war and conflict period did so at a time of distress or without proper evaluation of assets under the contract. In 2007, the government embarked on a review of mining contracts; an interministerial commission reviewed 61 contracts between state-owned enterprises and private companies. The commission's final report, published in March 2008, recommended that a third of the contracts be cancelled and two-thirds be renegotiated. As of February 2010, 16 contracts had been cancelled, and the others had been renegotiated.

investments could be launched and producing in the near term. Potassium and iron seem to be the most likely minerals for future industrial extraction. Potassium reserves are of a high grade, at relatively shallow depth, and located within 20–100 km of the major port, Pointe Noire. Finally, the SOREMI copper project could advance quickly; it also has the advantage of readily available infrastructure (a railway line) to transport the ore.

Depending on the international demand for commodities—primarily iron and other base metals—additional projects could be developed within 5 to 10 years. This will present great opportunities in terms of growth and diversification but will also raise significant challenges, especially in terms of governance, infrastructure development, and associated environmental impacts. The development of the mining industry will catalyze the development of infrastructure for transport and energy. Projects of that size demand a high level of government stability, commitment, and coordination, even more so when mining operations are of a regional nature, such as the Mbalam-Nabeba and Avima operations in the TRIDOM Interzone. For those operations, regional collaboration and coordination will be important.

Mining codes require companies to respect a country's environment. To get an exploitation license, a company must submit an environmental impact assessment and an environmental management plan. However, the ministries of the environment have limited capacity to review these reports. As in other countries in the Congo Basin, the laws in the Republic of Congo are unclear about mining activities in and around various categories of protected areas, as well as on overlapping mining and forestry permits.

GABON

Gabon is in fifth place in oil production in Sub-Saharan Africa and third place in manganese production in the world. The oil sector accounts for 80 percent of exports, 45 percent of GDP, and 60 percent of government revenue. Some 40 companies are active in the oil sector, operating in about 30 oil fields onshore and offshore. Oil production peaked at 370,000 barrels/day in 1997; it has since been on a declining trend owing to maturing fields and lack of new discoveries.

Manganese reached 3.3 million metric tons in 2008 and is the country's third largest export (after oil and timber) and a major pillar in the government's strategy to develop the mining sector as a mitigating measure to counter the steady decline in oil production. In recent years, the government has awarded manganese and iron ore concessions to Chinese companies. Uranium production started in 1960; it was halted in 1999 with the depletion of the known commercial deposits. However, interested has piqued again, and several exploration activities for uranium are currently taking place. Gabon also has considerable reserves of gold, uranium, diamonds, and niobium. The gold mining joint venture between Africa-based Managem International A.G. (63%) and SearchGold Resources Inc. of Canada (37%) started operations in 2011. Some 900 sites have been identified for potential exploitation.

Gabon also has a considerable but chaotic artisanal and small-scale mining (ASM) sector. This sector has been associated with smuggling and with safety, health, and environmental issues: encroachment in protected and fragile ecosystems, including bushmeat hunting and links with elephant poaching (Hollestelle 2012; Lahm 2002). According to some estimates, 5,000–10,000 artisanal and small-scale miners in Gabon primarily mine gold and (to a much lesser extent) diamonds. Artisanal mining, when done properly, can employ a significant number of people and contribute significantly to state revenues, with limited damage to the environment. Gabon, with its political vision of green economic development, conservation, and promotion of the mining sector, offers opportunities for the development of an environmentally responsive artisanal gold mining sector. The fact that, so far, no mercury is being used (as far as the researchers have been able to verify) is an additional positive factor that adds to Gabon's opportunities to mine "green gold" (Hollestelle 2012).

The iron ore deposit in Belinga represents the major mining development potential and the main environmental concern for the medium term in Gabon. The deposit is located in the upper Ivindo province in northeastern Gabon, 577 km from Libreville, in the middle of an important conservation priority area. Total resources are estimated at a billion tons of minerals with Fe content exceeding 60 percent. The development of the Belinga site will eventually involve the construction of a railway, a hydroelectric dam, and a deepwater port. Belinga was to have been the flagship that moved Gabon's economy from its reliance on oil. Instead, it has become a symbol of the difficulties the country faces in exploiting its vast mineral resources. For two years, Belinga has been idle while the government wrangles with China National Machinery and Equipment, the site's concession holder, over the slow pace of development. Meanwhile, public hostility is growing, as environmental campaigners have successfully challenged the lack of transparency of the deal, the low quality of environmental impact studies, and the mine and associated infrastructure's impact on nearby national parks. The sheer volume of ore at Belinga means that the government cannot afford to keep the project suspended forever.

The main challenges facing the mining sector in Gabon include an outdated policy and regulatory framework. Although Gabon has formulated a mineral sector strategy (Declaration de Politique Miniere) and a corresponding legal and regulatory framework, neither is in line with the government's objective to stimulate foreign direct investment in the mining sector. A review of the country's mining code is currently under way and will set out the legal and fiscal framework for new projects. A new version of the code is expected before the end of 2012, which some industry executives say will be the milestone in determining Gabon's attractiveness for investment. Other challenges include weak revenue transparency/sector governance and inadequate institutional capacity for policy formulation, contract negotiation, and sector monitoring, including a mining inspectorate and mining cadastre office. Some 80 percent of Gabon is covered by rainforest, which poses significant ecological issues for mining and requires a strategic framework for environmental management.

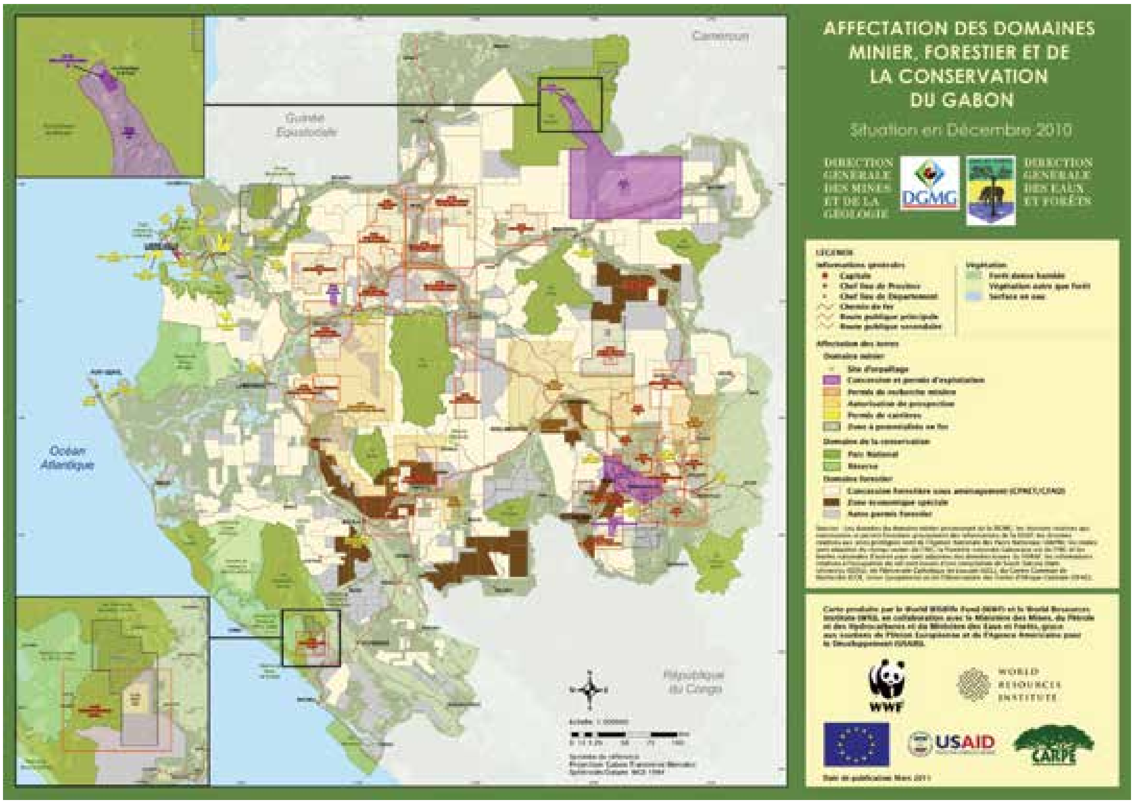
ASM very often takes place deep in the forest, where most of the remaining vulnerable wildlife is found. It is often linked to ivory poaching and bushmeat hunting. Transport links to isolated ASM sites are also used for ivory and bushmeat transport; miners themselves hunt around the site; and small traders in ASM camps engage in ivory purchases (which, with current high ivory prices, is very lucrative for hunters and traders alike). This observation is equally valid for the Republic of Congo, where ASM often takes place in remote forest areas rife with elephant poaching.

CENTRAL AFRICAN REPUBLIC

Mining is the largest source of export earnings for the Central African Republic, with diamond exports constituting 40–50 percent of export earnings and around 7 percent of GDP. In 2010, the Central African Republic was ranked 14th among the world's leading producers of rough diamonds by volume and 12th by value. The country also produces gold.

The Central African Republic has significant geological potential, with commercially exploitable deposits including alluvial diamonds, gold, uranium, and iron ore. Current largely artisanal mineral production includes diamonds, gold, clay, limestone, sand, and gravel. Alluvial diamond and gold production (the two largest mining activities in the country) occur in western Central African Republic, as well as in the center-east of the country (see figure A.2). Undeveloped mineral resources include uranium, iron ore, manganese, ilmenite, and rutile. Gold and diamonds come from the regions of Berberati, Haute-Kotto, and Haute-Sangha.

Figure A.1: Overlapping Mining (Exploration Permits) and Forestry Concessions in Gabon



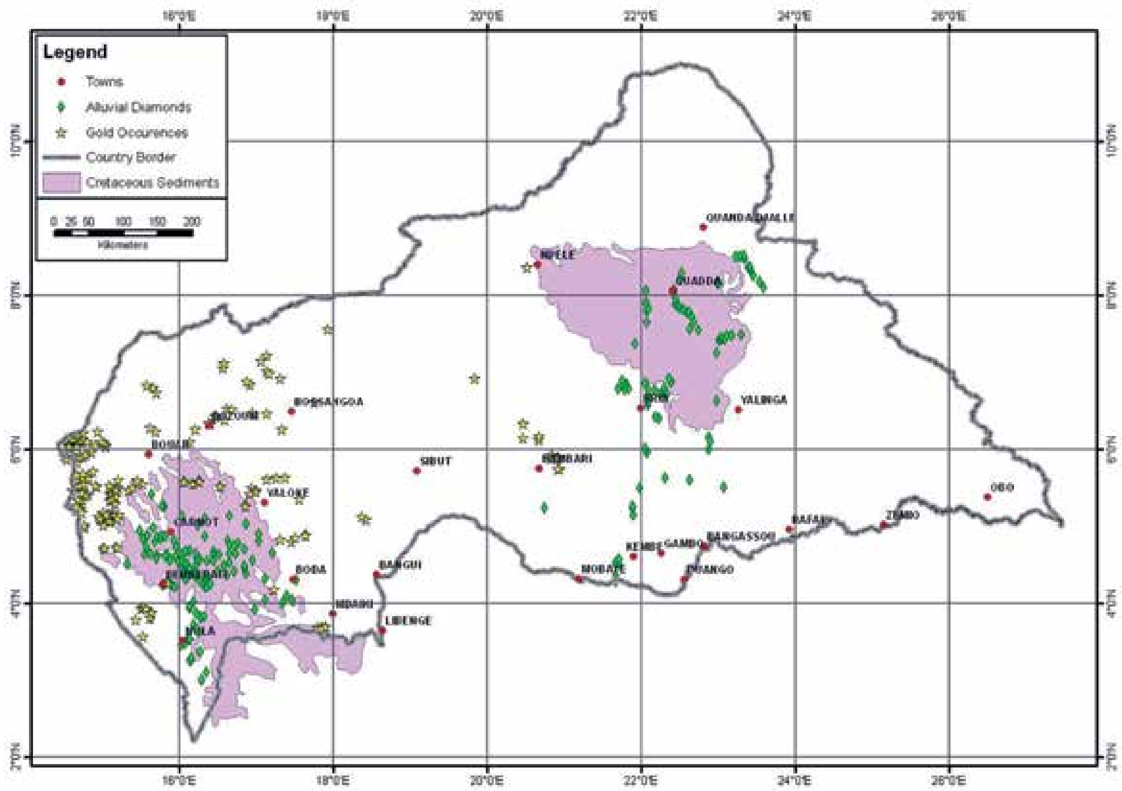
Source: WRI-WWF Gabon 2010. [add to refs]

Virtually all the diamonds and gold currently being produced in the Central African Republic are mined by artisanal and small-scale miners. The vast majority of diamonds and gold are mined in hundreds of small sites spread across the west and center of the country. ASM is an important livelihood for around 400,000 women and men in the Central African Republic and provides more than 60 percent of the country's export earnings (Levin 2010). In a country of approximately 4.4 million people, this means as much as 10 percent of the population is involved in artisanal mining as a means of livelihood. Most of the mining sites are in remote areas, far from modern infrastructure or government oversight.

While official statistics suggest that the mining sector contributes only 4–7 percent of the country's GDP, more than 95 percent of the Central African Republic's alluvial diamond production is attributed to artisanal miners. The likelihood of substantial losses in government revenue is high owing to production and sales outside the formal chain of custody. Minerals leave the country illegally through neighboring countries. These sales are not taxed or captured in official export statistics, and help foster a secretive culture within the artisanal mining sector, with little benefit sharing for local communities impacted by the artisanal mining activities. Large-scale industrial mining operations for gold, diamonds, and uranium have yet to begin, mainly because of security and licensing issues.

Large-scale mining is relatively new and underdeveloped in the Central African Republic. Gold, uranium, and iron in particular have potential for large-scale extraction but the security, economic, and governance setting is challenging. Because of the difficult

Figure A.2: Diamond and Gold Deposits in the Central African Republic



Source:

conditions, no large-scale mines currently operate in the country, although several companies have carried out extensive exploration activities in recent years.

The long-standing disparity between the strong potential of the Central African Republic's subsoil and its meager contribution to the economy prompted the government, through the ministry of mines, to overhaul the mining sector through a series of legal and institutional reforms, with the aim of ensuring that mining sector operations yield to development outcomes at both the national and artisanal mining community levels. The reforms have resulted in the amendment of the mining code and facilitated the creation of the National Union of Mining Cooperatives of the Central African Republic. Other reforms have positively but only marginally affected existing systems linked to diamond mining operations in the Central African Republic.

These include the establishment of the Office of Geological and Mining Research, the Gem and Mineral Trade Bureau, and the Special Anti-Fraud Unit.

Of particular significance is the gold and iron deposit at Topa in the southwestern portion of the country. The Central African Republic is engaged in a multilateral conservation area with Cameroon and RC (the Sangha Tri-National Region) near this location. The Topa deposit falls within the priority area and could pose conflicts with conservation priorities, especially if pressure increases to develop the area. With minimal infrastructure already in place, the impacts and disturbances to surrounding areas would likely be significant. If it is not well regulated, mineral and associated infrastructure development in this area could threaten the ability to conserve the wildlife habitat across borders (Reed 2007).

EQUATORIAL GUINEA

Offshore oil and natural gas production dominate Equatorial Guinea's nonrenewable resources industry. Most of Equatorial Guinea's hydrocarbon production is exported; some of the liquefied petroleum gas output is consumed locally. Clay, gravel, sand, and volcanic rock output are used by the domestic construction sector. The country appears to have few known mineral reserves outside of the oil reserves (USGS 2010).

Deforestation Trends in the Congo Basin:
Reconciling Economic Growth and Forest Protection

WORKING PAPER 4 | MINING

COMMISSION DES FORETS D'AFRIQUE CENTRALE
COMIFAC

THE WORLD BANK

1312648