



CHAPTER 7: MINING AND ENERGY EXTRACTION AND FORESTS IN TROPICAL AFRICA

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Diamond mine, North East Sierra Leone
Courtesy of Global Witness



CHAPTER 7: MINING AND ENERGY EXTRACTION AND FORESTS IN TROPICAL AFRICA

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Chapter summary

Mining and oil are highly profitable and widespread across tropical Africa, and for this reason they present a considerable challenge to forest conservation. Revenues from the extractive industries dominate export earnings for a number of African countries. Sub-Saharan Africa holds a large proportion of the world's mineral reserves, including 85 per cent of platinum, 60 per cent of cobalt, and 75 per cent of diamonds, and is home to 7 per cent of known oil reserves. A lot of mineral and fossil fuel resources are located in forest areas.

Mining and oil drilling can result in large areas of forest being cleared, but the 'forest footprint' of the mining and drilling can extend far beyond the site of extraction. New roads can, as with logging roads, expose forests to new drivers of deforestation and degradation, while the discovery of alluvial (meaning on the surface) deposits of gemstones, gold and coltan for artisanal and small-scale mining (ASM) can attract thousands of people to previously untouched forests to begin clearing trees, digging, and establishing settlements. The high value of minerals and fossil fuels makes it very difficult to stop extraction taking place when forests are threatened, and it will only become more difficult in the future as global economic growth drives demand. The research for this chapter concluded that philanthropy should focus on projects to reduce the impact of mining and oil drilling, rather than attempt to stop them completely.

The chapter identifies two key priorities:

- **Fostering a concept of 'reduced forest carbon impact' mining.** The mining industry appears to be responding very slowly to REDD and protecting forest carbon, and donors and funders could help to develop and promote mining practices that inflict less damage to forests, such as roadless extraction and reforestation of depleted sites.
- **Improving extractive industries regulation.** Improving regulations, for example, obliging companies to conduct environmental impact assessments (EIAs), which take into account the likely impact on forest carbon.



1. Introduction

The mining and energy extraction industries in Africa have, and will continue to have, a significant direct and indirect negative impact on Africa's tropical forests. Yet such are the revenues created by these activities that devising viable economic alternatives is highly unlikely. The best result obtainable for forests is damage limitation rather than cessation of extraction. This is a quite different context than the forestry sector, where much lower revenues indicate an opportunity for forest conservation to successfully compete, especially in the area of dormant (inactive) forest concessions. The challenge that donors and funders face in the extractive sector is to find ways of providing support for damage limitation initiatives that work with governments, international institutions and companies to achieve the lowest possible impact to Africa's tropical forests from extraction.

This is not to understate the threat. The relatively small role that the extractive sector appears to play in total African greenhouse gas emissions should not blind us to the actual and potential scale of the impact. Global demand for Africa's natural resources is steadily rising, and the carbon losses and forest ecosystem damage resulting from small and large-scale mining projects, though difficult to quantify accurately, are very significant. As foreign investors develop large-scale extraction projects, extensive areas of African tropical forest are degraded each year. In addition, the consequent need for massive infrastructure development – for example, roads, railways and pipelines – leads to further immediate and long-term deforestation.

To understand clearly the threat of the extractive industries it is critical to understand the current state of the sector in Africa. In addition to significant energy resources, Africa has a substantial proportion of the world's mining resources, which are spread across the entire tropical region. The impact of the sector, therefore, is not localised to one or two hotspots but is endemic across sub-Saharan Africa.

This mineral wealth is not only spread geographically, moreover, but also across many different minerals themselves. Africa exports gold, diamonds and platinum for luxury demand but also tin, aluminium, manganese and tantalum for building aeroplanes, batteries and cars. The extractive industries in Africa therefore generate very significant revenues not only for many different countries but also for many different international players. This is not a simple, localised game with one or two interested parties, but a hugely disparate group of industries, backed by vast multinational companies and international institutions.

Adding to the complexity of the industries' interaction with tropical Africa's forests is the disparity of the business models involved, from Large-Scale Mining (LSM) to Artisanal and Small-Scale Mining (ASM), and fossil fuels extraction. As one might expect, given the presence of multinationals and the revenues involved, many LSM projects are huge, formal, industrialised processes supported by government concessions and international capital. ASM operations, though usually operating at a subsistence level, present different but no less significant challenges to forest carbon, particularly as they are much harder to regulate or oversee. In addition, these operations are proliferating as a function of the economic slowdown and increasing human population pressures. Africa also has a considerable level of fossil fuels extraction, which has a significant impact on forest carbon both directly, through exploration activities, and indirectly, through increased infrastructure construction.

It is not surprising, therefore, that extractive industries have a substantial negative impact on Africa's tropical forests. It is not merely that serious levels of deforestation are occurring in countries such as DRC and Tanzania, where artisanal miners number in their millions, but it is also important to note that land around abandoned mines is slow to regenerate and that previously protected areas can



come under threat in the face of the potential for high profits from extraction activities. Indirect effects reach further still: newly created oil wealth can lower transport costs with a subsequent increase in logging and agriculture, and mines themselves can trigger additional logging to generate power. The uniquely dispersed nature of Africa's mineral wealth is such that this type of damage can occur on a huge scale, across a vast landmass.

Such is the growing demand for these resources that the pressure on Africa's mineral wealth is only likely to intensify in the future. Even with the economic crisis of 2008, Chinese and Indian investors have moved to maintain their interests in Africa's minerals. The demand for diamonds is increasing by 20 per cent annually in China alone;¹ and a boom in mineral prices prior to 2008 saw a sharp rise in the value of copper, nickel, gold and iron ore. At the same time as prosperity drives the demand for LSM, so declining economic conditions push millions into small-scale mining with their numbers expected to treble by 2015.²

The scale of the extractive industries in Africa, the wealth generated and the increasing global demand ensures that most interventions cannot be preventative but must be collaborative. When engaging with large-scale mining, most interventions will be necessarily focused on interactions with governments, international institutions, and multinationals. Viable economic alternatives to mining are practically impossible so the issue becomes how to minimise the impact, given the reality of the situation, and how to engage with the industry to prevent the worst excesses and permanent damage.

Donors and funders are therefore faced with one undeniable truth and two clear challenges: the extractive industries have, and will continue to have, a considerable negative impact on tropical Africa's forest carbon yet, currently, the idea of sustainable mining does not fit with REDD priorities; the scale of the revenues generated by the sector means there is no viable economic alternative. The threat of

the sector therefore must not be underestimated but any engagement must recognise that the interventions will be characterised more as curbing worst excesses rather than outright prevention.

A variety of interventions are therefore possible but their effectiveness will vary from country to country and project to project and be highly dependent on how much pressure can be brought to bear on the parties involved. The possibilities include:

Fostering a concept of 'reduced forest carbon impact' mining.

The mining industry appears to be responding very slowly to REDD and protecting forest carbon, despite the impact of the industry on forests. 'Sustainable mining' as it currently exists looks primarily at social issues and non-forest environmental issues such as water pollution. Donors and funders could help to develop and promote mining practices that inflict less damage to forests, such as roadless extraction and reforestation of depleted sites.

Improving extractive industries regulation. Philanthropy could also help by funding organisations that are trying to improve regulation in the sector – for example, obliging mining companies to reforest an area of land to compensate for the forest cleared on their sites or conduct environmental impact assessments (EIAs), which take into account the likely impact on forest carbon. Pursuing these reforms through existing regulatory initiatives such as the Extractive Industries Transparency Initiative (EITI) might be an option.



2. The state of extractive industries in tropical Africa

Tropical Africa possesses vast mineral and energy reserves, spread across the entire region. These resources generate very significant revenues for the governments involved but also often trigger the foreign investment necessary to begin large infrastructure expansions.

Africa is home to a large proportion of the world's mineral reserves: 30 per cent of bauxite, 60 per cent of manganese, 75 per cent of phosphates, 85 per cent of platinum, 80 per cent of chrome, 60 per cent of cobalt, 30 per cent of titanium, 75 per cent of diamonds and nearly 40 per cent of gold. Additionally, sub-Saharan Africa is an increasingly important player in the world energy market. It produces 7 per cent of global oil production and known reserves are of a similar magnitude.³ Despite the huge reserves already discovered, mining multinationals still spend some 16 per cent of total global expenditure on mineral exploration on Africa, with Nigeria, Mozambique and Madagascar all expected to hold further extractive potential.^{4, 5}

Africa's natural riches are not only geographically diverse but also offer a wide range of different resources. Mining in Africa is traditionally associated with precious metals or stones – gold, diamonds, platinum – and while these are significant, the continent actually produces a very wide range of metals for a very wide range of industries.

Table 1 shows that while Cameroon, for example, does produce gold for luxury goods, it also produces iron for steelmaking, tin for pewter and titanium for pipes. The DRC produces diamonds for jewellery but also cobalt for jet engines, and copper for musical instruments. In addition, the DRC is a major supplier of coltan (tantalum), which is used in the production of, amongst other things, mobile phones and laptop computers. This diversity of products challenges the assumption that mining in Africa is driven by the demand for luxury goods. The scale of the extractive sector in Africa is much larger and more complex than might superficially seem to be the case, and is driven by the demands not just of the global rich but also of the entire world economy.



Table 1: Common minerals in Congo Basin countries

Mineral	Commodity use	Country deposit
Gold	Ornamental, electronics, dentistry, decorative plating of jewellery, watchcases, pens and pencils, spectacle frames and bathroom fittings, decoration of china and glass	Equatorial Guinea, Gabon, Republic of Congo, DRC, CAR, Cameroon
Diamonds	Jewellery, industrial fittings, machinery	Gabon, Republic of Congo, DRC, CAR, Cameroon
Iron	Steelmaking, alloy	Gabon, Republic of Congo, DRC, Cameroon
Uranium	Nuclear fuel, nuclear weapons, X-ray targets, photographic toner	Gabon, Republic of Congo, DRC
Lead	Batteries, cable sheathing, lead crystal, solder and radiation protection, anti-knock compound in petrol, plumbing, ammunition	Gabon, Republic of Congo, DRC
Tin	Tinplates, alloys, solder, pewter, chemicals, panel lighting, frost-free windshields	Republic of Congo, DRC, Cameroon
Aluminium	Aircraft parts, automotive parts, railroad cars, seagoing vessels, packaging, building construction, electrical applications, pharmaceutical uses, water treatment	Republic of Congo, DRC, Cameroon
Manganese	Steelmaking, batteries, colourants and pigments, agriculture, water treatment, oxidising agents, odour control, catalysts, sealants, metal coating, circuit boards	Gabon, DRC
Copper	Building construction, aircraft parts, automotive parts, industrial applications and machinery, furniture, coins, crafts, clothing, jewellery, musical instruments	Republic of Congo, DRC
Titanium	Lightweight alloys, aircraft components, automotive components, paints, watches, chemical processing equipment, marine equipment	Republic of Congo, Cameroon
Cobalt	Super-alloy in jet and gas turbine engines, magnets, stainless steel, batteries, cemented carbides and diamond tools, pigments	DRC, Cameroon
Niobium	Alloys, stainless steel, corrosion-resistant alloys, gas turbines, rocket engines, plating, coins, catalysts, burglar-proof vaults, batteries	Gabon

Source: WWF. *Assessment of the mining sector and infrastructure development in the Congo Basin region*.¹



Revenues from the extractive industries dominate export earnings for a number of African countries: 76 per cent for Gabon, 98 per cent for Nigeria, and 61 per cent for Cameroon. Proportions in other countries in the region are similar.⁶ These numbers do not even truly reflect the scale of the resources in Africa because many countries (Botswana is a notable exception) have allowed foreign investors to reap most of the profits.

Although currently significant in financial terms, extraction in tropical Africa is in many ways still at an early stage and scaling up is inevitable. Tanzania, for example, is hoping to quadruple the size of its mining sector by 2025.⁵ But because tropical African economies are small in relative global terms, many countries can only obtain foreign investment by promising huge mining concessions. The DRC, for example, has recently accepted \$9 billion in investments from China in return for metal rights worth almost \$50 billion.^{7, 8}

While large extraction projects generate huge revenues and investment for governments, small-scale or artisanal mining can be much more lucrative for Africans than agriculture or logging. In the east of the DRC, for example, an artisanal coltan miner can produce a kilogramme of ore a day worth around 80 dollars (in 2000 prices), which is the equivalent of the annual income of most people in the region.² The economic significance of the extractive industries, therefore, cannot be ignored on any level.

2.1 Three types of mining and energy extraction in tropical Africa

Although the mining and energy industries are spread across tropical Africa, the nature and impact of their presence varies considerably from region to region. The analysis below identifies three extraction categories: large-scale mining (LSM); artisanal and small-scale mining (ASM); and fossil fuels extraction (oil, coal and gas).

2.1.1 Large-scale mining (LSM)

Large-scale mining is characterised by the involvement of at least one industrial company, using heavy machinery in the extraction process, and generally operating within a mining concession. LSM is therefore usually a formal industry, which makes contributions to state revenues and complies with legal requirements, although cases of fraud and even criminal activities from LSM companies are not uncommon. LSM investments in tropical Africa are also almost always foreign investments (except in Southern Africa), sometimes via partnerships with national companies.

Within the LSM sector in Africa, there are three groups of players: multinational corporations (eg, Rio Tinto); numerous 'juniors' (generally high-risk smaller companies); and new investors (mainly China, India and Brazil). In terms of the larger players, the sector is dominated by Australian, North American (particularly Canadian) and Asian firms, although Brazilian and Southern African companies are also important. Surprisingly, there are very few European companies operating in the region: some notable exceptions are Eramet and Areva (France) in Gabon and Central African Republic (for Areva only), DMC Iron (Austria) in Republic of Congo and Forrest (Belgium) in DRC. Although many large players are involved in LSM in Africa, numerically they do not dominate. In the DRC, the last census recorded only 10 companies that were listed in international stock exchange markets out of a total of 325 LSM companies operating in the region. In other words, 97 per cent of the companies operating in the LSM were not publicly listed.⁹



Courtesy of Global Witness



In addition to the involvement of multinationals, most LSM in Africa also involves the World Bank Group. Its role was initially focused on supporting exploration and production (from the 1960s to the early 1980s) but it has since evolved to advising on sector policy reforms and privatisations (1980s) and, more recently, to capacity building and private sector development (1990s). In the last 25 years, although lending for oil and gas activities was reduced, it was actually increased for mining, which the World Bank regards as a critical driver in the economic development of sub-Saharan Africa.

Within the World Bank Group, there are two key institutions: the International Finance Corporation (IFC), which provides loans, equity and technical assistance to stimulate private sector investment in developing countries, and the Multilateral Investment Guarantee Agency (MIGA), which provides guarantees against losses caused by non-commercial risks to investors in developing countries. The World Bank therefore is a critical player in the LSM sector, acting as a go-between for governments and multinationals and mitigating the political risk that often deters most foreign investors.

But as the World Bank and multinationals are beginning to dominate the LSM sector, so national governments are having to take a reduced role. According to one report, governments are no longer the biggest operators but do retain 10–20 per cent stakes in mining projects.⁹ The decreasing role of Gécamines, the public company that used to dominate the mining sector in the DRC, is characteristic of this trend. Founded by Mobutu in 1966, Gécamines at one time was solely responsible for some 85 per cent of DRC's export revenues from minerals. Poor management and corruption, however, led it to the brink of bankruptcy and it now largely operates in partnership with private parties (95 per cent of the DRC's copper production, for example, is now under joint venture management).¹⁰

The physical size of concessions and typical LSM projects are considerable. In the DRC, for example, diamond concessions

are often larger than 0.5 million hectares and can reach 1.6 million hectares in size. Unsurprisingly, projects at this scale have a corresponding need for infrastructure. In Cameroon, for example, a new 490 kilometre-long railway is being constructed to transport iron ore from the forests in the south of the country. In total, some \$3.3 billion will be spent on infrastructure to support this project – a level of investment almost unheard of outside the extractive sector. A strikingly similar project is developing on the other side of the border, in Northeast Gabon, at Belinga. Here, more than \$3 billion (from Chinese groups) will be invested in iron ore extraction and the building of a 560 kilometre-long railway, a deep-water harbour and a hydroelectric dam. In the DRC, BHP Billiton is developing a proposal for a \$3 billion aluminium smelter that would source electricity from the \$5 billion Inga 3 hydroelectric project, a total investment that is only marginally less than the country's entire 2007 GDP of \$9 billion.^{11, 12}

The LSM sector in Africa, therefore, is characterised by international companies, supported by the World Bank, mining very large concessions, supplemented by infrastructure expansion projects. The scale of these projects, moreover, brings in considerable investment that constitutes very significant proportions of foreign investment in Africa.

2.1.2 Artisanal and small-scale mining (ASM)

Unlike LSM, which is characterised by large, formal concessions, industrial machinery and the presence of international companies, ASM is by nature a labour-intensive activity that exploits marginal or small deposits of minerals. Yet although ASM is small in terms of individual scale, it actually employs far more people across sub-Saharan Africa than LSM. It also accounts for the majority of production of some minerals, particularly gemstones: some 70 per cent of diamond production in the DRC and Ghana is estimated to come from ASM, while in Central African Republic this is estimated at about 100 per cent.¹³



ASM involves two types of mining: artisanal and small-scale. The distinction is that artisanal mining may involve only individuals or families and is purely manual, while small-scale mining is more extensive and usually more mechanised. Fundamentally, ASM is a subsistence livelihood strategy. Unlike LSM, where huge revenues are generated, ASM attracts the poor and the desperate. In Malawi, for example, subsistence farmers mine gemstones in the dry season when there is less agricultural work.² As might be expected, therefore, given the conditions and the expertise involved, ASM is associated with low standards of safety and health, low rates of material recovery and significant impact on the environment.²

ASM involves millions of people spread across the entire sub-Saharan African region. Currently, it is estimated that around 5 million people work in ASM in this area with the largest numbers in the DRC, Tanzania and Zimbabwe (see Table 2). In the DRC alone, estimates range between 0.5m and 2 million people.¹⁴ Even countries with minimal mineral resources have significant ASM sectors: Ethiopia, for example, which is not a major mineral producer, is estimated to have over 400,000 people working in ASM, as is Eritrea.

More worryingly, it is forecast that these numbers will rise considerably as economic conditions worsen and opportunities for employment in other sectors decline. In Zimbabwe alone, the numbers of people in ASM are expected to treble by 2012 and by 2015 it is estimated that over 15 million people will be working in ASM in Africa.²

2.1.3 Fossil fuels extraction

In contrast to the metal resources in Africa, the continent's oil and gas riches are not as globally significant or as geographically diverse. There are far fewer oil and gas producing countries in sub-Saharan Africa and, in total, Africa has 10 per cent of the world's known oil reserves.¹⁵ However, it is still important to understand the impact and scale of the energy sector in Africa and why foreign investors are particularly keen on securing access to Africa's energy reserves.

Most of Africa's energy reserves are located on the western coast of Africa encompassing Nigeria, Cameroon, Gabon, Equatorial Guinea, the Republic of Congo and Angola. Sudan is now a major exporter of oil too. Yet although the energy industry is much less widespread than the mining sector, its economic influence is no less important. Energy exports account for 98 per cent of Nigeria's total exports, 92 per cent of Angola's, 80 per cent of Gabon's, and 74 per cent for Sudan.⁶



Diamond mine, Democratic Republic of Congo
Courtesy of Global Witness

Table 2: Estimates of the number of people working in the ASM sector in selected African countries

Country	Total number of workers
Burkina Faso	100,000–200,000
Ghana	200,000
Malawi	40,000
Mali	200,000
Mozambique	60,000
South Africa	10,000
Tanzania	550,000
Zambia	30,000
Zimbabwe	350,000

Source: Hentschel, *Artisanal and Small-Scale Mining: Challenges and Opportunities*, 2003.¹³



One key driver is that African oil is increasingly seen as critical for the US market. The US currently sources 15 per cent of its oil imports from sub-Saharan Africa, but this figure is estimated to rise to 25 per cent by 2015. And, although Africa contains probably only 10 per cent of the world's known reserves, it is increasingly important from another perspective: since 2000, Africa's west coast has accounted for about one third of the world's new oil discoveries.¹⁶⁻¹⁸ Therefore, although the energy industry is less important on the global scale, and limited to a smaller number of sub-Saharan African countries, it still dominates these countries economically and is seen as a key supplier of the US market (the largest in the world) in the short and long term.

African oil is attractive to the US (and the world) for a number of reasons. First, the quality of the oil is high. In industry parlance, African oil is 'light' and 'sweet', meaning it is cheaper to refine than Middle Eastern crude. As environmental regulations become stricter in the US and Europe, so the quality of Africa's oil becomes more appealing. Second, transport costs are much lower as Africa's oil is simply loaded on tankers at the point of production. Apart from Chad and Sudan's oil (and Nigeria's gas), there is no need to build pipelines and go through potentially unstable countries (contrary to the Caspian crude oil, for instance). Third, there are no state monopolies (unlike in the Middle East) and most ventures are production sharing agreements (PSAs), which allow foreign investors to reap large profit margins. Fourth, few African countries are members of OPEC, which allows companies to have greater flexibility over production limits. And, fifth, most new discoveries are offshore (a feature of African oil) and so Africa is seen as a key area for new discoveries.¹⁹

Foreign investors are therefore flocking to access Africa's oil and gas and so the nature of the energy industry in Africa is similar to that of large-scale mining: multinationals, often with support from the World Bank or the IMF, operate in joint ventures on vast concessions which produce revenues critical to the government. As Table 3 demonstrates,

many of the largest names in the energy industry are present in Africa, attracted by the quality of the oil and the (relative) ease of operation.

Much of Africa's oil and gas production is offshore, however there are major exceptions to this rule. In Nigeria, for example, much of the oil is under the Niger Delta and massive deforestation has already occurred to access the reserves. And the recent discovery of large untapped oil reserves in Uganda under the exceptionally biodiverse forests of the Albertine Rift has attracted the attention of investors and governments from all around the world. In another parallel to large-scale mining, the revenues from oil and gas and the projects themselves often lead to huge infrastructure expansion, which can have a critical impact on deforestation levels in Africa.

Table 3: Leading oil and gas companies active in Africa

Company name	Countries: gas/oil exploration
BP	Algeria, Angola, Egypt
Chevron	Angola, Nigeria
Exxon Mobil	Angola, Cameroon, Chad, Equatorial Guinea, Nigeria
Shell	Ghana, Nigeria, Cameroon, Gabon
High Resolution Technology & Petroleum	DRC, Namibia
ROC Oil Company Ltd	Mauritania, Equatorial Guinea, Angola, Madagascar
Chariot Oil and Gas	Namibia
Total (previously ELF)	Gabon, Nigeria
Angola LNG	Angola



3. Problems, challenges and future trends

This section expands on the extent and nature of the relationship between the extractive industries and tropical Africa. First, it discusses the different direct and indirect impacts of the mining and energy industries. Some of these are positive but most are clearly negative. It then outlines briefly the expected future trends in the industry and how this might affect the sub-Saharan African countries.

3.1 Impacts

As with the timber industry, the impact of the extractive industries on Africa's tropical forests can be divided into direct impacts and indirect impacts. On the one hand, mining and drilling often takes place in forested areas, and the clearing entailed in exploring and digging for minerals and fossil fuels can wreak havoc on forests in the direct vicinity. On the other hand, mining, both at the large-scale and artisanal or small-scale, and energy extraction can involve substantial infrastructure development or large settlements, which increase agricultural conversion, logging for timber and woodfuels, and hunting.

These indirect impacts mean that the 'forest carbon footprint' of a single mining or drilling project may extend far beyond the project site. At the same time, some commentators argue that not all indirect impacts are necessarily negative (relative to alternative development routes): prosperity engendered by extraction, particularly for oil, can lead to urbanisation and a lowering of reliance on agriculture and forestry, which in turn can lessen pressure on forests. We attempt to summarise some of the evidence for these points below.

3.1.1 Site specific damage alone is highly significant

There is an abundance of examples of the on-site damage that extractive activities cause. In Sierra Leone, it is estimated that mining practices have completely destroyed between 80,000 and 120,000 hectares of natural forest – equivalent to up to 5 per cent of Sierra Leone's total forest area according to the FAO – with minimal efforts at restoration.²⁰⁻²²



These images of the development of the Catoca diamond mine in north-east Angola, near the border with the Democratic Republic of Congo, illustrate how large mining operations can cover thousands of hectares. Catoca is one of the largest diamond minds in the world.
Courtesy of UNEP, Africa: Atlas of Our Changing Environment. 2008, UNEP: Nairobi, Kenya.
Available from: <http://www.unep.org/dewa/africa/AfricaAtlas/>.



Ghana perhaps offers the best single example of the scale of the damage that mining companies have inflicted on Africa's forests. Over 60 per cent of the Wassa West District, in the west of the country, is under concession to large-scale open pit gold mining, the greatest concentration of mining in a single area in Africa. One study notes *'large sections of Wassa West's tropical rainforest have been degraded by or lost to this gold mining boom since the 1980s.'*²⁰ In 2002, the total area under mining concessions was estimated at 5.8 million hectares, or 25 per cent of Ghana's total land area.²³

Another perspective on impacts is through estimates that use the total number of artisanal miners as a baseline. In countries such as the DRC, Tanzania and Zimbabwe, where artisanal miners number more than 0.5 million in each (up to 2 million in the DRC),¹⁴ the impact of the sector on forest carbon cannot be negligible. If we assumed that, on average, each of the 6 million people involved in ASM in Africa dig 0.1 hectares per year, this means that 600,000 hectares of land would be disturbed or damaged to some extent, each year. Data on the distribution of artisanal mining is not good enough to determine how much of this would be in forested areas, so it is difficult to translate this into a figure for deforestation. Nevertheless, the sheer scale of ASM activity across tropical Africa must be driving significant deforestation and degradation. When the impacts of LSM projects and concessions are added, the total direct loss of forest cover must be considerable.

3.1.2 Mineral deposits are often located in densely forested areas

Many of the mineral deposits in Africa are located in densely forested areas, often under an actual or nominal protected area designation. A WWF report notes that *'more than one-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 one-third of all active mines and exploration sites are located within areas of intact ecosystems of high-conservation value.'*¹

A good example is in Niger, where phosphorus and iron mining in the W National Park – a haven for 80 per cent of the country's biodiversity – threaten the ecological integrity of the area.²⁰ In Nigeria, oil production and exploration are degrading mangrove forests, and in Tanzania, gold mining in a protected forest area has increased the population of one village from a few hundred to about 40,000, underlining labour demographics as a significant factor in mining impacts on forests.²⁴

In the DRC, mining for coltan has wreaked damage on forests with high carbon intensities and high biodiversity.²⁵ It might be argued that coltan mining is the exception rather than the rule for the DRC, as mining activity is largely concentrated in the south-east and eastern parts of the country, notably in Katanga and Kivu Provinces, which lie outside the forest and river systems that are the highest carbon and biodiversity conservation priorities.¹ However, this could be purely temporal. The priority areas are rich in minerals, and if they are not adequately protected then an expansion of mining into these forest zones is likely to occur over the coming decades.¹

In some cases, mining can lead to a reclassification of protected areas. The Mount Nimba Strict Nature Reserve (Guinea and Ivory Coast) is an example. A World Heritage Site (WHS), this dense forest has high levels of species endemism, and is also a significant source of iron ore. One study reports that despite protests from environmental groups, a consortium of mining companies persuaded UNESCO to redraw the boundaries of the WHS to allow mining and other extraction activities.^{26, 27}



Artisanal mining for kaolin near Dar es Salaam, Tanzania. Kaolin is a white clay used in the manufacture of many products including paper and ceramics.
Courtesy of Thomas Sembrés



Studies have demonstrated the spatial correlation between 180 oil and gas concessions and biodiversity hotspots (measured by density of mammals, birds and amphibians) in the Western Amazon.²⁸ This comparison of maps is striking and, although similar studies for Africa are not readily available, the examples reviewed here suggest that in tropical Africa too, mining sites tend to coincide with areas of high carbon and biodiversity forests.

3.1.3 Mining sites have significantly slower natural forest regeneration

Studies have demonstrated the highly negative long-term impacts of small-scale gold mining on forest cover in Suriname. *'Forest recovery following mining is slow and qualitatively inferior compared to regeneration following other land uses...large parts of mined areas remain as bare ground, grass, and standing water.'* These impacts are generic to this type of mining activity, so the same effects can be extrapolated where they occur in tropical Africa.²⁹ Worryingly, in South Africa alone, mining wastes cover more than 200,000 hectares.²⁰

3.1.4 Extractive industries can drive infrastructure expansion

The extractive industries in Africa develop their own infrastructures (eg, railways from iron ore deposits in Gabon and Cameroon to the sea; the Chad-Cameroon pipeline). The impacts on forests are well documented. Infrastructure expansion not only directly results in high levels of deforestation and degradation but also creates access to previously remote areas, which can lead to increases in other activities that have deforestation impacts, such as agriculture and forestry. A WWF report notes *'Infrastructure development can be done in a number of ways, and although assessments of one particular project may indicate a limited impact, such projects should be viewed within the broader context of regional infrastructure development because the cumulative effects of such development are likely significant.'*¹

Large-scale mining is the most significant driver of infrastructure development in tropical Africa, with corporations (in partnership with

the World Bank and other multilateral institutions) providing investments in railways, road systems, deep-water seaports, hydroelectric dams and power generation plants. In very large LSM projects, the cost of infrastructure is sometimes larger than for the on-site mining operations. One example is the proposed BHP Billiton project in Muanda, DRC, which involves synchronising plans for a \$3 billion aluminium smelter with the Inga 3 hydroelectric project. A 2008 article reported that BHP Billiton agreed to loan the DRC government \$10 million to further develop the Inga project,¹² and a more recent article reports that the DRC has opted to accept BHP's proposal to build a 2,500 megawatt hydropower plant in the country to support its smelter.¹¹

Transport infrastructures probably have the most negative impact on forests. They are also the most common and are associated with virtually all LSM projects. Mining roads often open up previously inaccessible areas or reduce the transport costs of hitherto remote zones. They also increase forest vulnerability to fire through spatial fragmentation, as has happened in Ivory Coast.³⁰ Some research suggests that road construction and improvement is the most significant infrastructure driver of deforestation.³¹ The impacts are physical (road building through forest areas) and economic (reductions in transport costs open up remote areas to a range of activities).

3.1.5 Mining can place additional demands on surrounding forests

A good example of the demands that mining activities impose on forested land is the history of large-scale copper mining in Zambia. This began in Zambia's Copperbelt Province during the 1930s, attracting workers and turning this biologically rich savannah woodland into a heavily populated area. The mining industry was heavily dependent on woodfuels until hydroelectricity was made available in the 1960s.



Diamond mine, North East
Sierra Leone.

Courtesy of Global Witness



In the last decade before electricity came online, almost 130,000 hectares of woodland had been cleared to provide energy. The growing population attracted by the mining industry continued to rely on wood for fuel. When the industry collapsed in the 1990s, it left large numbers of workers unemployed, many of whom turned to small-scale agriculture and charcoal production to make a living, putting additional pressure on the surrounding woodlands.²⁰

ASM can have a negative impact on surrounding forests. As noted above, artisanal mining for coltan or diamonds can be lucrative compared to other opportunities to earn cash, such as farming cash crops, logging, or making charcoal. Discoveries of artisanal mineral deposits can attract thousands of workers to settle in previously intact areas of forest, who may then clear land for agriculture, hunt for bushmeat in the forest, and fell trees for timber and woodfuels. The forest footprint of an artisanal mine may therefore extend well beyond the vicinity of the mining activity.

3.1.6 Extractive industries may draw economic activity away from forests

Although the overall impact of the extractive industries on Africa's land carbon is highly damaging and widespread, some research argues that the oil and gas sector can produce positive impacts on forests. Large-scale oil and gas extraction produce revenues that increase per capita incomes for populations as a whole, and provide significant direct and indirect employment opportunities. There is evidence that oil production can help slow deforestation caused by agriculture and timber extraction: an oil boom may increase the value of a country's currency, which renders timber and agricultural exports uncompetitive on global markets, and reduces investment in cash crops and timber concessions. These factors combine to encourage a trend toward urbanisation, and this in turn lowers reliance on employment in forest-damaging agriculture and forestry, leading to reductions in timber and food exports.³²⁻³⁶

Gabon is often cited as a tropical African country where these positive impacts from an oil boom can be seen. There are two weaknesses in the argument. From an overall climate perspective, oil booms mark a continuing failure to shift away from fossil fuel emissions toward low carbon energy. In this sense, a shift from deforestation to oil and gas is merely a large-scale manifestation of leakage: the displacement of one emissions source by another. The second weakness is that oil booms are of short duration when viewed on any long-term time frame. Once Gabon's oil has been extracted, the country may turn again to agriculture and forestry for employment and export revenues.

However, it might be the case that at the end of Gabon's oil boom, the next phase of development could be dominated by metal extraction. One report notes this potential sequence in another African country: *'the exploitation of minerals in Cameroon, although found partially in forested areas, could potentially replace the wealth from oil and delay pressures to expand agriculture or logging further into forested areas. Higher oil prices seem to coincide with lower rates of deforestation. If true, the same scenario could also occur with mineral development, provided that mining does not open up extensive forested areas and is conducted under the best environmental and social safeguards.'*¹

There are familiar echoes here of the arguments over selective logging: the search for the 'least bad' deforestation and degradation strategies, where the goal is damage limitation rather than a reversal of trends. In the case of the extractive industries (unlike logging), it is difficult to see how forest conservation can successfully compete with revenues that are derived either from oil and gas or from metals extraction. At the same time, relativistic logic which packages partial forest destruction as a positive can introduce dangerous distortions into the REDD debate.



3.1.7 Urbanisation and extractive industries

Fossil fuel extraction and LSM attract workers away from agriculture and forestry (although not from ASM, which is associated with subsistence strategies) and contribute to urbanisation directly through the provision of employment (both in transport hubs and at the extraction point) and indirectly by contributing to the national budget, which is deployed with bias toward developing the urban economy in Africa.

Extractive industries thus drive urbanisation. Some studies suggest that urbanisation is a good thing for forest conservation, but the impact on forests is ultimately ambiguous. On the one hand, migration from rural to urban areas is assumed to relieve the pressure on forests because migrants are often young adults (those most responsible for forest clearing and new family formation). Cities are assumed to make economies more efficient, thus reducing the rate of natural resource use relative to economic product. If early urbanisation tends to be detrimental to forests, by being dependent on resource extraction, advanced urbanisation is expected to be beneficial, as organisation and services improve. Studies estimate that the tipping point arrives when more than 26 per cent of the labour force is involved in services.^{37, 38}

However, there are other effects of urbanisation that can have detrimental impacts on forests. Urban expansion uses timber, which may be logged from national forests. If urbanisation is associated with rising incomes, it will likely be accompanied by increased consumption of meat, which may be met by hunting bushmeat or increasing livestock production, which could encroach on forests. If it is associated with the creation of ‘mega slums’ (the dominant pattern of urbanisation in tropical African countries), it will be accompanied by growing charcoal consumption, which will have a devastating impact on forests around major towns and cities (see the Woodfuels chapter). Lower rural population densities could also open the door for large-scale agriculture.³⁹

3.2 Coal, oil and gas as alternatives to woodfuels?

Some see fossil fuels as a preferable alternative to woodfuels that could help protect Africa’s tropical forests. In Niger, the president of the National Association of Wood Users commented *‘recourse to coal as a source of domestic energy is a healthy initiative, in the sense that it will allow us to save our forests from altogether disappearing.’*⁴⁰ In Nigeria as well as Niger, coal is seen as a much-needed alternative to fuelwood and an important weapon against deforestation.⁴¹

In other countries, oil and gas are believed to be useful tools in decreasing the reliance on fuelwood and charcoal. In Malawi, recent rising oil prices have increased the country’s reliance on fuelwood (to over 90 per cent of energy use), putting additional pressure on forests.²⁰ In Ghana, Benin and Togo, it is hoped that the West African (Chad-Cameroon) Gas Pipeline will reduce the pressure on forests by encouraging households to shift from fuelwood to gas for their domestic consumption.⁴²

Substituting fossil fuels for woodfuels could reduce total levels of consumption, and relieve some pressure on forests, but faces a number of practical problems. First, most fossil fuels produced in tropical African countries are exported to overseas markets, rather than consumed domestically. Second, most fossil fuels are not affordable or available to most people in tropical Africa, especially in rural areas. Promoting fossil fuels is probably not as effective at reducing deforestation and forest degradation as increasing the efficiency of woodfuel cooking stoves, diverting woodfuel production away from natural forests toward plantations, or introducing cheaper alternatives like briquettes (see the **Woodfuels** chapter). Furthermore, in the context of climate change, the long-term goal for Africa, like the rest of the world, should be renewable, low-carbon energy – promoting coal-fired electricity on a massive scale would have serious consequences for climate change.



3.3 Is LSM more sustainable than ASM?

Is one form of mining inherently more sustainable (from a carbon perspective) than another? This is a controversial issue. Some argue that only LSM can comply with best practices, but others claim that ASM is inherently more sustainable since it avoids using heavy machinery and does not trigger massive infrastructural development projects.

The argument for large-scale mining is that *‘the environmental costs of ASM are in general higher than those of other types of mining. This means that ASM is dirtier per unit of output than medium-sized or large and modern mining operations. Another problem of ASM is the great individual number of polluters, normally concentrated in a specific area, which causes significant local impacts. It is very difficult to control or monitor environmental violations or enforce regulations because of the lack of resources and the inaccessible nature of most operations.’*¹³

ASM seems more destructive than LSM, therefore, on-site and per unit of output. However, if one takes into account off-site and indirect impacts

(through infrastructure development and urbanisation notably), it is virtually impossible to provide a definitive answer to the initial question. In any case, the debate is less relevant than might be imagined because both models are rarely true alternatives to each other. Geological features generally dictate which of ASM or LSM is best suited (small deposits of gemstones are typically exploited by ASM while oil fields or large deposits are developed by large corporations).

3.4 Can REDD compete with mining developments?

The extractive industries generate huge resources for many tropical African countries. Yet, while such revenues are critical to the development plans of many countries, these mining and energy projects can have significant direct and indirect negative impacts on forests. The unpalatable truth, however, is that such is the scale of the revenues generated by these projects that even the most profitable REDD scheme cannot compete on economic terms. Mining sites generate revenues that, at a minimum, generate or imply prices of over **\$100,000** per hectare (see Table 4).

Table 4: Price per tonne of CO₂ required to avoid deforestation in selected mines

Name	Country/Metal	Size (ha)	Cost (NPV=0, \$ million)	Price Per ha (\$)	Necessary price of t/CO ₂ given following level of dense tropical rainforest (\$)				
					20%	40%	60%	80%	100%
Tenke Fungurume ⁴³	DRC/Copper-Cobalt	143,700	1,890	13,152	75	37	25	19	15
Kolwezi ^{44, 45}	DRC/Copper-Cobalt	6,200	553	89,194	505	253	168	126	101
Dikuluwe and Mashamba ^{46, 47}	DRC/Copper-Cobalt	15,235	250	213,325	1,209	604	403	302	242
Akyem ^{48, 49}	Ghana/Gold	1,216	700	575,658	3,262	1,631	1,087	815	652
Dutwa ^{50, 51}	Tanzania/Nickel	75,000	450	6,000	34	17	11	8	7
Lumwana ⁵²	Zambia/Copper	135,500	862	6,367	36	18	12	9	7



The **Akyem** gold mine in Ghana, for example, affects around 1,216 hectares of land. The cost for constructing the mine and bringing revenues on line is estimated to be \$700 million. This implies an average cost of **\$575,658** per hectare. Not all of this land is dense forest and not all the dense forest present would qualify for deforestation credits (in other words, not all of it would necessarily be deforested by the project). But even if we conservatively assume that the project will generate a zero NPV (in other words, that the revenues generated over the lifetime of the mine will only be equivalent to the original \$700 million invested), and generously assume that the entire site is pristine rainforest with high levels of carbon content,ⁱ and that 100 per cent of the land therefore generates carbon credits, the price per tonne of CO₂ would still need to be around **\$242** to break even with the gold mine. Currently, forest carbon credits on the voluntary market are priced around \$3; in other words, prices would need to rise by approximately **8000 per cent** to break even.

The story is much the same even with less valuable metals in less developed countries. The **Kolwezi** mine, a copper-cobalt mine in the DRC, spans 6,200 hectares and will cost approximately \$553 million (around **\$89,000** per hectare). Again, assuming a zero NPV for the mine, and implausibly generous assumptions for the revenue potential of any REDD project, the price per tonne of CO₂ would need to reach over **\$100** to break even (over a 3000 per cent increase).

The minimum break-even carbon price in Table 4 using this approach is \$7, for the **Dutwa** and **Lumwana** projects, in Tanzania and Zambia respectively. At first, this looks quite promising (in terms of REDD competitiveness) but this figure needs to be put in perspective. First, it is still almost double the current prices for voluntary credits. Second, it relies on the entire project area in both projects being dense

pristine forest with high levels of carbon. This type of forest is rare in both countries. When a more plausible 20 per cent of forested land is assumed, the break-even price becomes a more challenging **\$35** (over a 1000 per cent increase).

Another perspective is to compare these figures with estimates for the NPV of a large-scale REDD project (see the **Forestry** chapter). In an article on the competitiveness of REDD, Rhett Butler of Mongabay.com estimated that the NPV of a REDD project spanning 830,000 hectares in Cameroon was \$64 million.⁵³ This implies a break-even cost per hectare of \$77. In Table 4, the lowest price for any mining site is approximately \$6,000 per hectare. In other words, a REDD project would need to be **77 times** more profitable than the Economist estimates to compete with the cheapest mining project. The numbers are clearly unambiguous: REDD monies simply cannot compete with the extractive industries. There may be rare cases where paying for 'avoided extraction' will be possible, if sufficient political will exists, such as in the case of Ecuador (see below).⁵⁴ However, in most cases there are other better and more realistic uses of donor funds available, as we explore below.

3.5 Future trends

In recent years, the extractive industries have dominated foreign direct investment (FDI) to Africa. In 2006, FDI flows to Africa totalled \$36 billion – a new high – '*in large part related to investments in extractive industries*'.⁵⁶ This increase was spurred on by rising commodity prices, and focused on a relatively small number of African countries, with 10 countries accounting for \$32 billion of FDI. In West Africa, Nigeria was the main destination, accounting for 80 per cent of the investment, '*dominated by FDI in its oil industry, mainly from China*'.⁵⁶ In Ghana, inflows tripled to \$435 million, largely as a result of investment by two US mining firms: Newmont Gold Company and Alcoa. In Central Africa, investments went to Equatorial Guinea, Chad, Republic of Congo and Cameroon reflecting '*greater spending by TNCs on oil and mining exploration*'.⁵⁶

ⁱ We assume the carbon content of intact tropical rainforest is 240 tonnes per hectare – see the **ProForest annex**. This is a generous estimate, as any forests on the mining sites used in the examples in Table 4 are more likely to be degraded semi-dry woodland, which stores much less carbon per hectare than dense rainforest.



In Cameroon, for example, investments by Total and Pecten Cameroon were the major cause of the surge. In East Africa, foreign investments rose after a sharp decline *‘as a result of new oil exploration activities in non-traditional producer countries.’*⁶ Tanzania had the highest inflows in the region (\$377 million), ‘most of it due to investment for expansion in the mining industry’, while FDI in Uganda rose by 19 per cent, *‘as a result of investments from Australia in the oil industry.’*⁶

But the onset of the global downturn in 2008 has seen the extractive industries, and particularly the mining sector, hit hard. Base metals were particularly affected: nickel prices fell to \$8.07 per pound in September 2008 after reaching a high of \$16.89 in 2007. Some mining stocks lost 80 per cent – or more – of their value and so the entire industry has begun to slow down its investments and exploration activities. Africa is regarded as relatively high risk in the global context, and thus investments have been disproportionately affected. In 2009, the African Development Bank noted that *‘mining companies are cutting both production and exploration of new mines. Due to the decline in global demand, copper production in the Democratic Republic of Congo (DRC) declined from 34,215 tons in June 2008 to 23,562 tons in October 2008. A similar trend is observed for cobalt and diamonds. As a result, 40 companies in the DRC extractive sector closed at the end of 2008 and over 300,000 jobs were lost.’*⁵⁵

A return of global growth will likely see a rebound in the price of metals, and subsequent resumption of many operations and new exploration and site development. In overall terms, many African countries place the extractive industries at the centre of their economic strategy, and this seems set to continue. In some cases, this involves reforms that increase government revenues. In Tanzania, for example, the government had plans to introduce a mining bill in 2009, which would give the government a 10 per cent stake in all Tanzanian gold mines, remove tax breaks and incentives for mining companies and increase royalty payments. The country hopes to increase the contribution of the extractive sector to GDP from 2.5 per cent

to 10 per cent by 2025.⁵ But in Uganda, the government (through the Uganda Investment Authority) appears to be pursuing a policy of incentivising the extraction sector, through 100 per cent deductibility of exploration expenditure, a variable rate income tax for mining and zero rate duty on mining equipment.⁵⁶ For many countries trying to begin ambitious development programmes, investment from the extractive industries is a necessary first step.

3.5.1 China

The rapid scale up of Chinese investment in natural resources in recent years is a global phenomenon, but is particularly marked in Africa. In 2009, Chinalco launched a \$20 billion approach for a stake in Rio Tinto, one of the largest global mining companies. Bids totalling AUD\$4 billion have been lodged for major Australian companies and billions have been invested in markets such as Kazakhstan and Mongolia. China is being particularly active in buying risky assets that Western companies are reluctant to approach. China’s NFC Africa will now run the Zambian Luanshya Copper Mine, which had been closed due to the financial crisis. The DRC has announced plans to accept \$9 billion in investments from China, to be channelled into mining and infrastructure – despite the opposition of the IMF. In return, China will receive metal assets valued at around \$50 billion.

The economic crisis has intensified the investment trend, as China is in some cases the only willing investor, and African governments are facing severe budgetary deficits. This trend can be expected to continue in the short to mid term. Until 2015, global demand for metals is likely to remain flat apart from in China, where rising demand, for example, will soon account for some 44 per cent of global steel consumption.⁵ Against this backdrop, and with Chinese companies still sitting on large cash reserves, it is likely that more expansive moves will be made through 2010. Given the vulnerability of African economies, it would seem likely that many of their prime assets will be targeted. This will mean more pressure on Africa’s tropical forests.



4. Interventions and responses

The damage caused and the threat posed by the extractive industries is abundantly clear. At a glance, however, the opportunities for donors and funders to get involved in protecting forest carbon from mining and energy extraction appear very limited. The problem is two-fold. First, the scale and economic influence of the mining and energy sectors is such that preventing, or even constraining, their activities is practically very difficult.

Second, the concepts of REDD and forest carbon have not yet entered the vocabulary of the extractive industries, or the NGOs, development banks and regulatory bodies that work with them: industry initiatives and NGO campaigns focus on issues such as corruption, poor working conditions for miners, conflict resources (money from the sale of diamonds has been used to fund bloody rebel conflicts in several tropical African countries),⁵⁷ and non-carbon environmental issues such as water pollution and bushmeat hunting.

Many of these interventions do provide frameworks for addressing deforestation and degradation. This section outlines the potential interventions in this area, and their strengths and weaknesses. Most of these will be focused on LSM; not because its impact is greater than ASM but because the latter is so atomised and unregulated that credible interventions are scarce. Three broad categories of intervention can be recognised: *process-related* (project approval and assessment processes, and related rewards and penalties); *engagement* (working with the industries to limit damage to Africa's tropical forests, or campaigning to influence corporate actions and behaviour), and *industry regulation*.

4.1 Process-related interventions

These interventions – Environmental Impact Assessments (EIA) and a range of offset instruments – are focused on affecting the process

by which mining projects are approved and assessed. EIAs are used prior to mining projects to determine the trade-off between environmental damage and economic reward while biodiversity offsets are designed to compensate for damage caused by mining or energy projects. Both are useful and can be powerful tools, but equally, neither is sufficient and the existence of one can undermine the effectiveness of the other. Donors and funders need to push for stricter standards for both interventions to make both more effective as individual and combined interventions.

4.1.1 Environmental Impact Assessments, and the Equator Principles

The Environmental Impact Assessment (EIA) is probably the most widely used tool for improving environmental management in the mining sector but its effectiveness is reduced by quality and implementation issues.² There are no firm technical standards for gathering data and assessing the potential impacts while damaging exploration projects often fall outside the purview of EIAs altogether. If EIAs are to be part of a successful campaign to limit the impact of the mining and energy industries, then their standards and remit need urgently to be reviewed and tightened.

This is not straightforward. EIAs are complex processes that need skilled professionals and clear international standards and measures. Yet, in reality, as one observer notes: their implementation is often abysmal.² The central issue is that there are no international standards for gathering baseline hydrological data, assessing archaeological remains, predicting acid drainage, measuring carbon impacts, or identifying key flora and fauna. This allows EIAs to be performed by poorly qualified individuals and consultancies, which undercut reputable firms who understand that sound methodologies are not cheap or quick. Regulators, moreover, are neither incentivised nor sufficiently well informed to be able to reject substandard work.⁵⁸



Recently, the idea of EIAs has, in theory, been strengthened by the Equator Principles,⁵⁹ an initiative of major financial institutions that have pledged not to provide loans to projects that do not comply with the Principles' environmental and social policies and processes. The extent to which the Principles have had a significant impact on large-scale infrastructure and other developments is hotly contested. It does not appear to be difficult to identify large-scale development projects funded by EP-supporting lenders that do not meet many of the EP and IFC guidelines (a good example is the Baku-Tbilisi-Ceyhan (BTC) oil pipeline).⁶⁰

In addition to implementation issues, EIAs also suffer from shortcomings in their remit. Often EIAs are only used to assess production activities and not exploration projects – when the latter can be as damaging as the former. A good example is Sinopec's activities in Gabon when prospecting for iron ore, which involved seismic arrays and explosions causing significant damage to the surrounding areas.¹ Yet other exploration approaches, such as the use of 3-D imaging or helicopters, can have much less impact and these issues need to be part of the EIA process.

EIAs, therefore, are a widespread and accepted tool in managing the damage caused by the mining and energy industries. Yet, to be properly effective, there must be progress on improving and regulating the standards used in the process, so regulatory bodies have the appropriate information, and expanding the overall remit, so all impacts of projects, from exploration to exploitation, are considered. The example of the EP demonstrates that unless consistent and clear standards are applied, then internal regulation by financial institutions or regulatory bodies is highly unlikely.

4.1.2 Biodiversity offsets

Biodiversity offsets are essentially conservation projects designed to compensate for damage caused by industrial development.

A number of example projects are included in the IUCN/Shell Building Biodiversity Business report.⁶¹ The goal of biodiversity offsets according to the Business and Biodiversity Offsets Program is to achieve '*no net loss, or preferably a net gain, of biodiversity on the ground with respect to species composition, habitat structure and ecosystem services, including livelihood aspects.*' This definition is consistent with the broader understanding of 'offset' as a conservation activity that takes place outside the geographic boundaries of a development site in order to compensate for damage caused.⁶²

The biodiversity offset approach could easily be adapted to include forest carbon and forest ecosystem services within existing or new instruments: where biodiversity offset projects involve reforestation or assisted forest restoration (see the **Conservation** chapter for definitions), they may have substantial benefits for forest carbon.

Although less widespread and recognised than EIAs, biodiversity offsets seem to have potential as credible interventions, yet as with EIAs, there are inherent challenges with implementation and assessment standards. At the same time, the very presence of offsets can undermine the EIA process, because the existence of an offset component risks taking attention away from environmental standards in other project aspects.

On the other hand, biodiversity offsets have gained considerable support, from major donor agencies and companies as well as NGOs (partners include Conservation International, Fauna & Flora International, Wildlife Conservation Society, KfW, USAID and the IFC). This is not a guarantee of rigour or commitment, but does demonstrate a welcome willingness to engage in collaborative work. The partnership is currently testing the concept with pilot projects and is developing a suite of handbooks to assist in design, implementation and evaluation of biodiversity offsets.⁶³



Diamond mine, North East
Sierra Leone
Courtesy of Global Witness



Examples of biodiversity offsets in Africa include the controversial Chad-Cameroon pipeline project. A more ambitious example is outside of Africa, in Ecuador. Here, in addition to reforesting the areas that were cleared to lay the pipeline, a consortium of companies agreed to put nearly \$17 million into an Ecuadorian environmental trust fund, corresponding to about 1.2 per cent of the cost of the project (estimated at \$1.4 billion). Although this is very small in percentage terms, given the overall scale of the project, it is still significantly more than the Chad-Cameroon pipeline, where the cost of the offset (\$3.5 million, including the Indigenous Peoples Plan) is only equal to 0.1 per cent of the cost of the project (\$3.5 billion).⁶⁴

Biodiversity offsets are clearly becoming an option for highly visible extraction projects in sensitive areas but there are significant problems with how the ‘no net loss’ rule is implemented in practice. A good example of this can be seen in Rio Tinto’s ilmenite mine in Madagascar, where the biodiversity offset has been constructed against the baseline (or assumption) that most of the island’s forest would have been destroyed within 40 years anyway. To offset the damage the project will cause (the loss of 17,000 hectares of forest in a unique littoral ecosystem that contains several endemic species), Rio Tinto is planting a range of fast growing trees to reduce dependence on the natural forest for fuel and timber, the protection of approximately 1000 hectares of littoral forest remnants in three or four conservation blocks; and the rehabilitation of wetland areas, and approximately 600 hectares of native forest. These offsets only meet the ‘no net loss’ rule under the 40 year assumption.⁶⁵

4.2 Engagement interventions

These interventions involve different forms of engagement with the mining and energy industry or national governments, which may help limit or minimise the damage caused to Africa’s forests. This includes campaigning, exploring ‘leave it in the ground’ strategies, supporting roadless extraction techniques, and targeting exhausted mining sites for forest restoration. In the LSM sector, the presence of

multinationals with shareholders predominantly based in developed nations perhaps offers the best opportunities for engaging with the extractive sector and forcing more focus on protecting Africa’s forests.

4.2.1 Campaigning: Canadian companies as a target?

Canada has a substantial presence in Africa’s mining sector. Various reports claim that 60 per cent of mining companies operating in Africa are Canadian-owned or funded with Canadian capital. The vast majority of Canadian companies are relatively small.^{66, 67} In the DRC, one Canadian company, Banro, is reported to have acquired 47 mining concessions covering about 1 million hectares.⁶⁷ Other Canadian companies operating in Africa include Kinross-Forrest, Barrick Gold, Emaxon, Lundin, Mindev and Anvil Mining.

It might be that the large presence of Canadian companies in Africa offers some opportunities for campaigning or lobbying for greater emphasis on restoring Africa’s land carbon. Certainly donors and funders need to recognise that high-level engagement with such companies and campaigns, which pressurises them to focus on protecting Africa’s forests, is a necessary element in any overall interaction with the extractive industries. The revenues produced by these industries means that the overall strategy must be one of curbing the worst excesses and high-level engagement will clearly be part of this.

4.2.2 Avoided extraction

An ambitious approach is that some countries can be persuaded ‘to leave the resources in the ground’ if compensated for the lost revenue. This has gained wider attention since 2007 when Rafael Correa, the President of Ecuador, announced that his country would leave its major oil reserve untapped (located beneath the main forest national park of the country) if it received financial compensation from the international community.²⁸ This type of strategy may be an option where the political will is present, but as our calculations above demonstrate (see Table 4), in most cases the compensation that



would be needed to equal the revenues generated from extractive industries projects would be impossibly high. That said, this option might be worth exploring in the case of smaller deposits, and engaging with governments to explore this issue might be a worthwhile option for donors and funders.

4.2.3 Roadless techniques

Another potential intervention is pressurising energy and mining companies to employ roadless techniques. Given that infrastructure expansion is one of the key drivers of deforestation, this would seem to be an obvious tool in reducing the impact of the extractive industries on Africa's forests. Moreover, similar approaches have already been used in other countries. Roadless oil extraction is a feature of the new Petrobras project proposal in Ecuador, which seeks to obtain government approval for drilling into a famous national park.²⁸ This demonstrates that (at least some) oil companies are ready to use roadless techniques (it is still profitable). Equipment and people can be transported by helicopter to the extraction site, and/or the future pipeline can be roadless. Roadless techniques are already sometimes the preferred option for exploration activities in Africa and this intervention seems a highly practical issue with which to engage companies operating in this area.

4.2.4 Sustainable mining closure

Most attention is paid to the immediate damage caused by ongoing mining activities and the issue of closed mines is often ignored. Natural regeneration of forests on closed mines is particularly slow: old mining sites can have a lot of pollution, and they can take decades to recover from the removal of top-soil, which contains the nutrients for vegetation to grow. Greater regulation of the process of closing mines and the responsibilities of companies in this area could produce significant results. In South Africa alone, mining wastes occupy 200,000 hectares.²⁰ Figures for all of Africa are not available but are likely to be very significant.

Haller Park in Mombasa, Kenya, is one example that rehabilitating land on mining sites is possible. This wildlife park used to be a cement quarry. A rehabilitation project was begun on the site in the 1970s by Dr René Haller, a Swiss-born environmental scientist. The first step was to plant tree species that were resilient enough to survive in the harsh conditions of the quarry floor. Insects that fed on the leaf litter of the trees were introduced and, over time, the top-soil recovered. Haller Park is now reportedly home to over 30 species of animals and plants on the IUCN Red List of Threatened Species.⁶⁸ Forcing companies to agree to a process of sustainable mining closures and fund ambitious timber plantation programmes on abandoned sites could be a very significant tool in mitigating the damage caused to Africa's forestland carbon. There is not much research or focus on this issue, and so this is an area in which donors and funders could contribute by supporting efforts to rectify this lack of attention.



Courtesy of Global Witness

4.3 Regulatory interventions

These interventions involve some form of regulatory approach to try to improve the governance of these industries and encourage policies that reduce the impact of the extractive industries. Given the dispersion of the ASM industry and the scale of the LSM sector, the potential interventions are not numerous. The Extractive Industries Transparency Initiative (EITI)⁶⁹ is not directly related to forest conservation and restoration, but might play a role in improving the transparency of the industry, while certifying the ASM industry is seen as a key element in trying to bring a degree of control in a largely unregulated part of the sector.



4.3.1 Extractive Industries Transparency Initiative

Launched in 2002, EITI aims to improve the governance of natural resources revenues in developing countries so that they contribute to poverty alleviation and economic development; promotes a standard for companies to publish what they pay, and for governments to reveal what they receive. As of March 2010, Liberia is the only African country that is compliant with EITI's standards but 20 other African countries (including all Congo Basin countries) are EITI candidates.ⁱⁱ The EITI designated Liberia as compliant on 14 October 2009.⁶⁹

Theoretically, the more transparent the extractive industries in Africa, the more practical it will be to engage with companies and governments in promoting approaches that minimise damage to Africa's tropical forests. Given the scale and riches involved, EITI might well be a key element in the overall strategy to minimise the worst excesses of the extractive industries' impact in this context.

4.3.2 Eco-certification of ASM activities

Some NGOs favour the development of low-impact ASM. They argue that, as in the forestry sector, artisanal and small-scale operations can have a significantly lower environmental impact than LSM because they avoid most of the damage caused by heavy machinery. Most NGOs probably also see ASM as preferable to large-scale, foreign-owned developments, which have failed to bring the expected benefits to the rural poor in many cases. In doing so, these NGOs seek best standards and aim to respond to a growing demand for ethically produced minerals.

Although such campaigns tend to focus on social standards first (for example, the German NGO Fair Trade e.V. has established links with a women's diamond cooperative in Lesotho and gems producers in Madagascar and Tanzania), they can have a very positive impact on forested areas.

The Association for Responsible Mining (ARM) actively emphasises environmental issues in addition to wider socio-economic concerns and one ARM member, the Green Gold Corporation, claims that an estimated 7,900 hectares of rainforest have been protected by these initiatives.²

ⁱⁱ The only other country that is currently compliant with the EITI standards is Azerbaijan.



5. Conclusions

The extractive industries sector has caused and will continue to cause significant damage to Africa's tropical forests. Global demand for Africa's oil and gas and metals has dipped to some extent because of the global economic slowdown, but in many cases this has provided opportunities for Chinese and other Asian investors. Overall, the coming decades are likely to see a steadily rising supply and demand curve. And, because tropical Africa has such vast reserves of untapped mineral wealth (much of it beneath forests), the rate and scale of extraction could accelerate.

The environmental impact of all forms of extraction – large-scale mining (LSM), artisanal and small-scale mining (ASM), and oil and gas is huge. ASM workers number in their millions, land around abandoned mines is painfully slow to regenerate, while the infrastructure needs of the industries drive yet more deforestation as roads, ports and railways are constructed.

The damage caused by the extractive industries is clear but their scale and economic significance means that no single intervention is likely to be sufficient. Donors and funders can help by strengthening the process by which mining activities are approved and regulated, thus helping to avoid much of the deforestation caused by the extractive industries. In addition, by pressurising the bodies involved (companies, governments and international institutions), further deforestation can be minimised by better governance, certification of ASM initiatives and roadless techniques. In combination with appropriate offsets (which should be repositioned as *net gain* rather than *no net loss*) and the positive effects of increased urbanisation (that is in part driven by the extraction industries), these interventions could help shift the sector toward a more limited impact.

However, donor realism on the scale of what might be achieved is sensible. This is not an area of the deforestation challenge in tropical Africa where transformation is within reach. Instead, incremental progress is likely to be the best that can be achieved.

5.1 'Reduced impact' mining

It is striking that, as opposed to the forestry sector, there is no coherent set of 'reduced impact' techniques tailored to mining activities. 'Sustainable mining', in so far as it currently exists, is a broader concept that looks primarily at social issues and non-forest environmental issues – water for example. It is possible that roadless extraction and other similar techniques could be moulded into a coherent model for 'reduced impact mining'. This might help to establish the concept as a REDD model. In the **Forestry** chapter, we argue that 'reduced impact logging' is a very dangerous concept in the tropical African context, in large part because full forest conservation and restoration is a genuinely viable economic alternative to the dominant logging concession model.

By contrast, a 'reduced impact mining' model would appear to be virtually the only achievable approach in the extractive industries context. This is because the continuation and scaling up of extraction across tropical Africa is unstoppable – the revenues and other benefits are simply too great for any African government to forego. As a result, 'reduced impact mining' that seeks to limit damage rather than transforming mineral concessions into forest conservation areas is likely to be the best available option in many instances.



5.2 Interventions must be combined to be properly effective

A variety of interventions are possible but their effectiveness will depend on how efficiently they are used in combination. Offsets could work very effectively with EIAs, for example, but, equally, if implemented wrongly, could undermine them and create even greater damage. Focusing on urbanisation might bring some benefits in the long run but also significant short-term damage. The obvious opportunities for donors and funders, therefore, are not numerous but they do exist and are credible options.

The process by which extractive projects are approved, carried out and ended can be strengthened considerably. EIAs must have clear international standards and be conducted by reliable scientists. Equally, offsets must not be allowed to undermine the strength or finality of EIAs, nor be weakened by inappropriate baselines. Closed mines could be subject to ambitious replanting programmes and roadless techniques should be employed where possible. These are all possible and credible outcomes that can be achieved by engaging with the companies, governments and world bodies involved. Campaigning might also be effective – particularly in Canada. Donors and funders can help by supporting these interventions and facilitating high-level engagement with the main players in these industries. Equally, reform of the extractive industries must also be supported, as transparency in these areas will facilitate other interventions. Donors and funders can provide support and funding for those countries that participate in the EITI and link their support of other programmes to the progress of these campaigns.

It might seem that such is the scale and economic dominance of the extractive industries, and the vast damage they cause, that the actions of donors and funders in this area will inevitably be insufficient. This is not true, however. A range of credible interventions is possible but the entire spectrum of opportunities must be employed and used as a group to achieve the greatest results.



6. References

1. Reed, E. and M. Miranda, *Assessment of the mining sector and infrastructure development in the Congo Basin region*. 2006, WWF. Available from: <http://assets.panda.org/downloads/congobasmining.pdf>.
2. International Institute for Environment and Development (IIED) and World Business Council on Sustainable Development (WBCSD), *Breaking New Ground: Mining, Minerals and Sustainable Development - Final Report, in Mining, Minerals and Sustainable Development*. 2002. Available from: <http://www.iied.org/sustainable-markets/key-issues/business-and-sustainable-development/mmsd-final-report>.
3. Yager, T.R., et al., *2006 Minerals Yearbook: Africa*. 2006.
4. MEG, *Special report on world exploration trends*. 2009, Metals Economics Group.
5. BMI, *Tanzania Mining Report Q3*, in *BMI Industry Report and Forecasts*. 2009, Business Monitor International.
6. Miroux, A., J. Dunning, and K. Vieu, *World Investment Report: Transnational Corporations, Extractive Industries and Development*, in *World Investment Report*. 2007, UNCTAD.
7. Asia Times Online. *China has a Congo copper headache*. 11 March 2010 21 June 2010; Available from: http://www.atimes.com/atimes/China_Business/LC11Cb02.html.
8. Commodity Online. *Controversy over China mining investment in DRC*. 08 September 2009 21 June 2010; Available from: <http://www.commodityonline.com/news/Controversy-over-China-mining-investment-in-DRC-20981-3-1.html>.
9. Comité Interministériel pour la Coopération Internationale et le Développement (CICID), *Ressources minérales et développement en Afrique: document d'orientation stratégique / Mineral resources and development in Africa: Strategic guideline document*. 2008. Available from: http://www.diplomatie.gouv.fr/en/IMG/pdf/618_Ressources_minerales_DOS.pdf.
10. Putzel, J., S. Lindemann, and C. Schouten, *Drivers of Change in the Democratic Republic of Congo: The Rise and Decline of the State and Challenges for Reconstruction*. 2008, Crisis States Research Centre, London School of Economics: London, UK. Available from: <http://www.crisisstates.com/download/wp/wpSeries2/WP26.2.pdf>.
11. AllAfrica.com. *DRC pulls plug on Inga*. 2010 [cited 2010 13 March 2010]; Available from: <http://allafrica.com/stories/201003010977.html>.
12. Mining Weekly. *Inga 3 feasibility tenders expected this year, says BHP Billiton aluminium president* 2008 [cited 2010 13 March]; Available from: <http://www.miningweekly.com/article/inga-3-feasibility-tenders-expected-this-year-says-bhp-billiton-aluminium-president-2008-05-23>.
13. Hentschel, T., F. Hruschka, and M. Priester, *Artisanal and small-scale mining*, in *Mining, Minerals and Sustainable Development*. 2003, IIED.
14. Garrett, N., *The Extractive Industries Transparency Initiative & Artisanal and Small-Scale Mining: Preliminary Observations from the DRC*. 2007, Extractive Industries Transparency Initiative (EITI).
15. OPEC, *Annual Statistical Bulletin 2009*. 2010, Organization of the Petroleum Exporting Countries (OPEC): Vienna, Austria. Available from: <http://www.opec.org/library/Annual%20Statistical%20Bulletin/interactive/2009/FileZ/Main.htm>.
16. The Boston Globe. *Oil in Africa*. 10 March 2005 20 July 2010; Available from: http://www.boston.com/news/specials/oil_in_africa/.
17. Telegraph.co.uk. *Africa's oil boom shifts balance of power*. 17 July 2008 20 July 2010; Available from: <http://www.telegraph.co.uk/news/worldnews/africaandindianocean/angola/2420477/Africas-oil-boom-shifts-balance-of-power.html>.
18. Ghazvinian, J. *Untapped: the scramble for Africa's oil*. 2007; Available from: <http://www.slate.com/id/2163389>.
19. Boston Globe. *Oil in Africa*. 2005 December 29, 2005 1 October 2009; Available from: http://www.boston.com/news/specials/oil_in_africa/.
20. UNEP, *Africa: Atlas of Our Changing Environment*. 2008, UNEP: Nairobi, Kenya. Available from: <http://www.unep.org/dewa/africa/AfricaAtlas/>.
21. Fonseca, H., *Mining: Social and Environmental Impacts*. 2004, World Rainforest Movement.
22. Food and Agricultural Organization (FAO), *Global Forest Resources Assessment 2005*. 2006, FAO: Rome, Italy. Available from: <ftp://ftp.fao.org/docrep/fao/008/A0400E/A0400E00.pdf>.



References continued

23. World Rainforest Movement (WRM), *Ghana: IMF, mining, and logging*. 2002. Available from: <http://www.wrm.org.uy/bulletin/54/Ghana.html>.
24. WWF, *Gold mining threatens Tanzania's threatened forests*. 2004. Available from: http://www.panda.org/about_wwf/where_we_work/africa/where/tanzania/news/index.cfm?uNewsID=13083.
25. Fauna & Flora International (FFI), *Coltan Mining in the Democratic Republic of Congo: How tantalum-using industries can commit to the reconstruction of the DRC*. 2003. Available from: <http://www.fauna-flora.org/>.
26. WWF and IUCN, *Metals from the forest: mining and forest degradation. arborvitae*, 1999. Jan.
27. WWF, *To Dig or Not to Dig? Criteria for determining the suitability or acceptability of mineral exploration, extraction and transport from ecological and social perspectives. A discussion paper for WWF*. 2002. Available from: http://www.wwf.org.uk/filelibrary/pdf/to_dig_or_not_to_dig1.pdf.
28. Finer, M., et al., *Oil and gas projects in the Western Amazon: threats to wilderness, biodiversity, and indigenous peoples*. 2008. 3(8).
29. Peterson, G.D., Heemskerk, M., *Deforestation and forest regeneration following small-scale gold mining in the Amazon: the case of Suriname*. Environmental Conservation 2001. 28: p. 117-126.
30. Kanninen, M., et al., *Do trees grow on money?: the implications of deforestation research for policies to promote REDD*. 2007, Bogor, Indonesia: Center for International Forestry Research (CIFOR). 61p.
31. Chomitz, K.M. and D.A. Gray, *Roads, Land Use, and Deforestation: A Spatial Model Applied to Belize*. World Bank Economic Review, 1996. 10(3).
32. Wunder, S., *Oil Wealth and the Fate of the Forest: a comparative study of eight tropical countries*. 2003: Routledge.
33. Wunder, S., *Macroeconomic change, competitiveness and timber production: a five-country comparison*. World Development, 2005. 33(1): p. 65-86.
34. Wunder, S. and W.D. Sunderlin, *Oil, Macroeconomics, and Forests: Assessing the Linkages World Bank Research Observer*, 2004. 19(2).
35. BBC News. *Oil drilling can protect forests*. 2003 26 June 2003 15 May 2009]; Available from: <http://news.bbc.co.uk/1/hi/sci/tech/3023470.stm>.
36. Congo Basin Forest Partnership (CBFP), *State of the Forest*. 2006: Congo Basin Forest Partnership.
37. Ehrhardt-Martinez, K., E.M. Crenshaw, and J.C. Jenkins, *Deforestation and the Environmental Kuznets Curve: A Cross-National Investigation of Intervening Mechanisms*. Social Science Quarterly (Blackwell Publishing Limited), 2002. 83(1): p. 226-243.
38. Jorgensen, A.K. and T.J. Burns, *Effects of Rural and Urban Population Dynamics and National Development on Deforestation in Less-Developed Countries*, 1990–2000. Sociological Inquiry, 2007. 77(3): p. 460-482.
39. Fearnside, P., *Will urbanisation cause deforested areas to be abandoned in the Brazilian Amazonia?* Environmental Conservation, 2008. 35: p. 197-199.
40. Issa, O., *From wood to coal in a effort to stop deforestation*. 2004. Available from: <http://www.energybulletin.net/node/2718>.
41. Mukumbira, R., *Nigerian environmentalists support coal mining*. 2008. Available from: <http://www.mineweb.com/mineweb/view/mineweb/en/page68?oid=54877&sn=Detail>.
42. Safo, A., *West African Pipeline by 2002*. 1999. Available from: http://findarticles.com/p/articles/mi_qa5327/is_/_ai_n28733673.
43. Nilsson, J., R.G. Simpson, and W. McKenzie, *Technical Report for the Tenke Fungurume Project, Katanga Province, DRC*. 2009, Prepared for Lundin Mining Corporation. Available from: http://www.lundinmining.com/i/pdf/TenkeFungurume_Technical_Report-March_31_2009.pdf.
44. First Quantum Minerals Ltd, *Kolwezi*. 2008. Available from: <http://www.first-quantum.com/i/pdf/KolweziFactSheet2008.pdf>.
45. Infomine, G. *Kolwezi (Luilu & Kingamiambo)*. 22 Marcg 2010]; Available from: <http://www.infomine.com/companies-properties/reports/propertyreport.aspx?pid=13830&part=3>.
46. Mineweb. *China's DRC investment \$9 billion - \$3 billion for mining*. 23 March 2010]; Available from: <http://www.mineweb.com/mineweb/view/mineweb/en/page67?oid=47452&sn=Detail>.
47. International Mining magazine, *King Katanga*. 2007. February p. 12-16.



References continued

48. CorpWatch. *GHANA: Dispute over Newmont's proposed gold mine at Akyem*. 16 October 2006 23 March 2010]; Available from: <http://www.corpwatch.org/article.php?id=14172>.
49. BMI, *Ghana Mining Report Q3, in BMI Industry Report and Forecasts*. 2009, Business Monitor International.
50. Fox Business. *Statement re Dutwa Project Update*. 21 January 2010 22 March 2010]; Available from: <http://www.foxbusiness.com/story/markets/industries/industrials/statement-dutwa-project-update/>.
51. Project Finance International. *Dutwa funding options open*. 9 September 2009 23 March 2010]; Available from: <http://www.pfie.com/416197>.
52. Equinox Minerals Ltd. *Lumwana Project*. 23 March 2010]; Available from: <http://www.equinoxminerals.com/Development/Lumwana-Project>.
53. Mongabay.com. *Carbon traders, not conservationists, could save Cameroon rainforest*. 15 February 2008 30 November 2009]; Available from: <http://news.mongabay.com/2008/0215-cameroon.html>.
54. National Geographic. *Ecuador puts a price tag on untapped oil*. 10 June 2010 21 June 2010]; Available from: <http://news.nationalgeographic.com/news/2010/06/100610-energy-ecuador-untapped-oil/>.
55. African Development Bank (ADB), *Africa and the Global Economic Crisis: Strategies for Preserving the Foundations of Long-term Growth*. 2009. Available from: <http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/The%20Global%20Economic%20Crisis%20and%20African%20Economies%20-%202012%20May%20-%20REVISED.pdf>.
56. Mutende, J., *Uganda's investment climate and opportunities*. 2007, Uganda Investment Authority.
57. Global Witness. *Combating Conflict Diamonds*. 22 March 2010]; Available from: http://www.globalwitness.org/pages/en/conflict_diamonds.html.
58. *Carbon sequestration*. Forest Products Journal, 2002. 52(9): p. 8-8.
59. *The "Equator Principles"*. 2006; Available from: <http://www.equator-principles.com>.
60. Baue, W., *New Bank of America Policy Sets Best Practice on Climate Change in US Bank Sector* 2004. Available from: <http://www.socialfunds.com/news/article.cgi/1429.html>.
61. Bishop, J., et al., *Building Biodiversity Business*. 2008. Available from: <http://www.iucn.org>.
62. Business and Biodiversity Offsets Program (BBOP). [cited 2010 13 March]; Available from: <http://bbop.forest-trends.org/>.
63. Nazari, M. and D. Proebstel, *Biodiversity Offsets in Mining*. Environment & Communities 2009.
64. Ten-Kate, K., J. Bishop, and R. Bayon, *What are biodiversity offsets?* 2004, Business and Biodiversity Offsets Programme. Available from: <http://www.biodiversityeconomics.org/>.
65. Mongabay.com. *Mining and biodiversity offsets in Madagascar: Conservation or 'Conservation Opportunities?'*. 30 August 2009 30 August 2009]; Available from: http://news.mongabay.com/2009/0830-rowan_rio_tinto_madagascar.html.
66. Tougas, D. Canada in Africa: *The mining superpower*. 20 November 2008 21 June 2010]; Available from: <http://www.pambazuka.org/en/category/features/52095>.
67. Missakabo, M., *Footprints and paradoxes of Canadian mining in the DRC*. Pambazuka News, 2008(407).
68. The Haller Foundation. *How it all started*. 28 May 2010]; Available from: <http://www.haller.org.uk/how-it-all-started/>.
69. Extractive Industries Transparency Initiative (EITI). 22 March 2010]; Available from: <http://eititransparency.org/>.