Making Mining Forest-Smart

EXECUTIVE SUMMARY REPORT

THE WORLD BANK, 2019

PROFOR
INNOVATION AND ACTION FOR FORESTS

WORLD BANK GROUP

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Acronyms

ASM	artisanal and small-scale mining
EIA	environmental impact assessment
ESIA	environmental and social impact assessment
FAO	Food and Agriculture Organization (of the UN)
FPIC	free, prior and informed consent
GDP	gross domestic product
ICMM	International Council on Mining and Metals
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
LSM	large-scale mining
MFA	large-scale mine in forested area
PROFOR	Program on Forests
REDD+	Reducing Emissions from Deforestation and Degradation and associated co-benefits
RMD	Raw Materials Database

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Acknowledgements

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Photo credit: Cassie Matias

Overview

Mining activities are taking place in forest landscapes. With anticipated growth of the mining sector, driven by the rising demand for minerals and metals and a proliferation in their uses, there are growing concerns around the spread of mining in forests and the impacts for biodiversity and ecosystem services. These and many other forest-based benefits are vital to the livelihoods and well-being of more than a billion people around the world. More "forest-smart" approaches to mining that enable development of the sector while maintaining forests and the supply of essential ecosystem goods and services are urgently needed. This summary synthesizes key findings and recommendations from three studies, which assess the extent of mining in forests, identify the first known lessons learned for implementing a forest-smart approach to mining, and analyze the opportunities and challenges for implementing biodiversity offsets to compensate for residual impacts of mining on forests. These studies aim to support the World Bank Group and its clients in ensuring that mining in forest landscapes contributes to the Group's corporate goals of ending extreme poverty and promoting shared prosperity in a sustainable manner.

Introduction

Photo credit: David Peters

Background

Forests are critical to sustainable development and for mitigating global climate change

Photo credit: Jeremy Holden/FFI

Forests cover about a third of the planet's surface, absorb vast amounts of carbon, and hold immense environmental and social value.

So far, the world has lost about half of its forests and deforestation in some countries is ongoing, contributing to the continued decline in net global forest cover. In 2017, the tropics experienced 15.8 million hectares of tree cover loss (an area about the size of Bangladesh) (Gibbs, Harris, and Seymour 2018). The widespread loss of forests can have significant, potentially irreversible effects (for example, for water regulation, loss of protection from natural hazards, and reduced biodiversity and carbon storage) (Lange, Wodon, and Carey 2018). **The implications for global climate change are stark.** According to figures released by Global Forest Watch Climate, if the tropical forests were a country, it would rank third in carbon dioxide–equivalent emissions, only behind China and the United States of America (Gibbs, Harris, and Seymour 2018)

BOX 1

The Importance of Forests for Sustainable Development

According to formal economic calculations, forests contribute some 1–2 percent of global gross domestic product (GDP) and represent an important source of employment: the formal forest sector employs more than 13 million people, with a further 40 million employed in the informal sector and another 840 million using forests to collect fuelwood (FAO 2014). They also provide a wealth of uncosted and incalculable values. Forests protect watersheds that supply fresh water to rivers—critical sources of drinking water—while more than 40 percent of the world's oxygen is produced by tropical forests (IUCN 2012). Holding 80 percent of global terrestrial biodiversity, forests generate numerous ecosystem services, from fuel, food, and fiber to climate resilience and flood protection. As a result, more than a billion people, or a fifth of the global population, may depend on the services generated by forests, including some 300–700 million indigenous people (Chao 2012).

Figure 1
Economic activity is driving forest degradation and loss around the world

Photo credit: Juan Pablo Moreiras/FFI

The cause of forest loss and degradation is economic activity (Figure 1). Commercial and subsistence agriculture are the main drivers, but mining plays an important though less understood role, accounting for an estimated 7 percent of total forest loss across Africa, Latin America, and Asia (Hosonuma et al. 2012). Mining is also associated with a range of other social and environmental impacts, from the contamination of soil, air, and water through the release of heavy metals, to the degradation and fragmentation of forest and other habitats, loss of species, and impacts for the quality and quantity of ecosystem services.

Mining operators are facing increased scrutiny from local and international stakeholders to mitigate and manage their impacts through the application of the mitigation hierarchy* with a growing number of large-scale, industrial mining projects seeking to compensate for their residual impacts on forests and other ecosystems through voluntary certification and assurance schemes, commitments to no net loss and net gain objectives, and the application of biodiversity offsets (Box 2).

* The mitigation hierarchy is a tool designed to help mitigate and manage the impacts of development activities for the environment and particularly for biodiversity. The mitigation hierarchy involves sequential application of the following steps: avoidance, minimization, rehabilitation/restoration, and, as a last resort, offset/compensate. For more information, see: *http://bbop.forest-trends.org/pages/mitigation_hierarchy.*

The mining sector continues to grow in response to rising demand for minerals and metals and a proliferation in their uses (Ali et al. 2017). To meet this demand, more metals will need to be produced between now and 2050 than over the past 100 years (Vidal et al. 2017). The sector makes a significant contribution to the global economy and especially to a growing number of low- and middle-income countries where mining's contribution to government revenues, direct employment, and livelihoods can be significant (ICMM 2016).

The global transition to a low-carbon society will further trigger a substantial increase in demand for a variety of minerals and metals (Figure 2). Cobalt and Lithium mining, for instance, has been growing due to market demand for electric vehicles and electronics (IGF 2017).

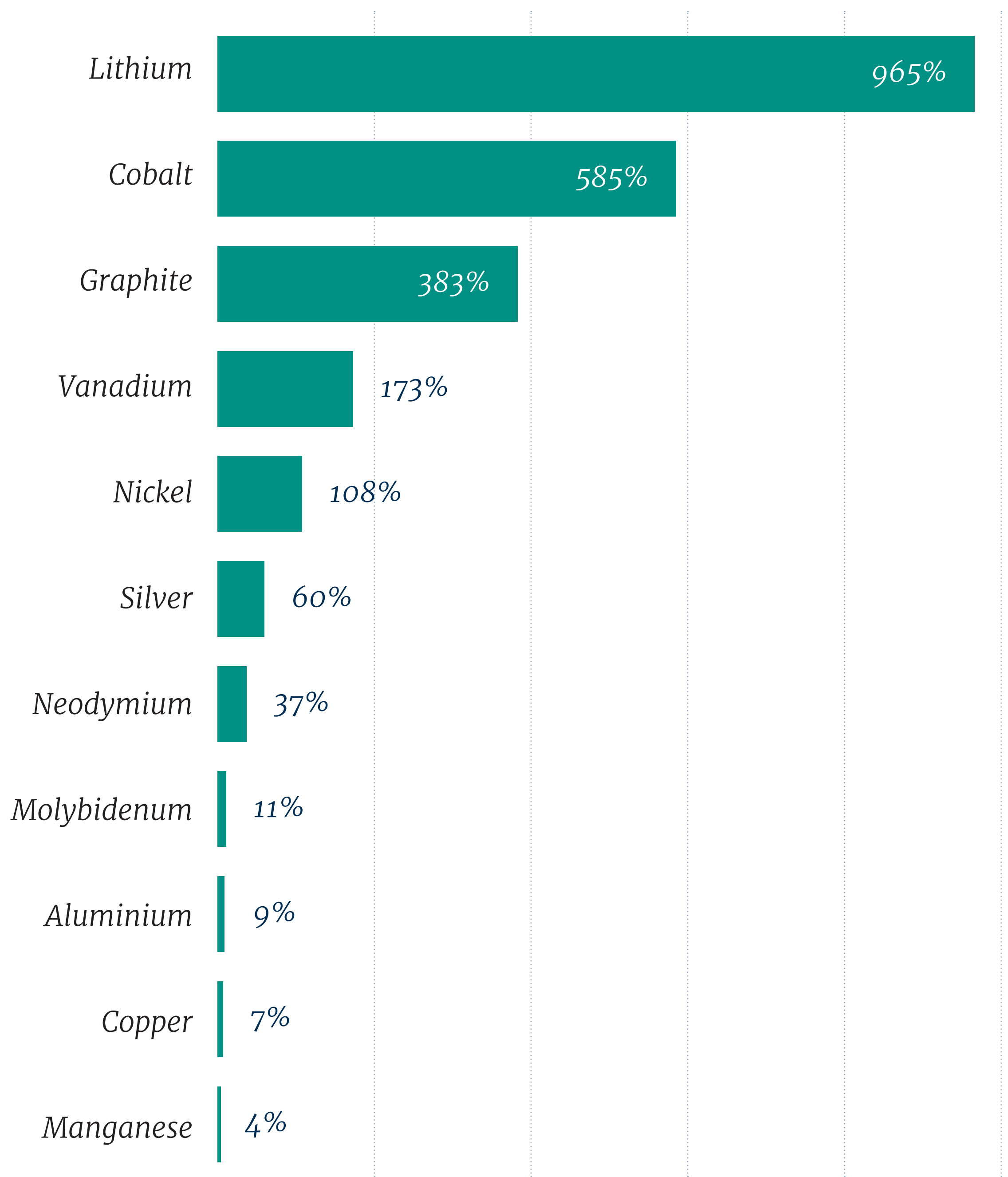
Rising demand and technological advances are enabling access to ever more remote and sensitive areas and there are growing concerns that mining will spread into sensitive forest landscapes, contributing to deforestation and forest degradation. Given the urgent need to protect and restore forests as a critical strategy for mitigating global climate change and achieving sustainable development, more forest-smart approaches are urgently needed (Box 3).

BOX 2

The Rise in Biodiversity Offsetting

Biodiversity offsets are an option of last resort, after all efforts to avoid, minimize, and restore or rehabilitate adverse impacts for biodiversity have been applied. They are expected to fully compensate for specified residual impacts (to the level of no net loss or preferably net gain) in a way that is measurable, long term, and additional to any other (ongoing or planned) conservation measures. Securing offsets for the long-term is therefore crucial. Recent analyses by Bull and Strange (2018) point to the rapid and spatially diffuse growth of the global biodiversity offset portfolio, with more than 12,000 biodiversity offset projects (relating to all sectors, not just mining) covering an area larger than 100,000 square kilometers. The bulk of offset activity both in terms of the number of offsets and offset extent is reported to be in less industrialized and emerging economies.

Figure 2
Projected Annual Mineral Demand from Clean Energy Technologies in 2050 (2DS*)
Percentage of 2017 Annual Production



Source: International Energy Agency, Energy Technology Perspective (ETP) 2017, Deetman et all (2018), World Bank Analysis (2018)
*ETP-2DS: Scenario where there is at least a 50% chance of limiting the average global temperature increase to 2°C by 2100

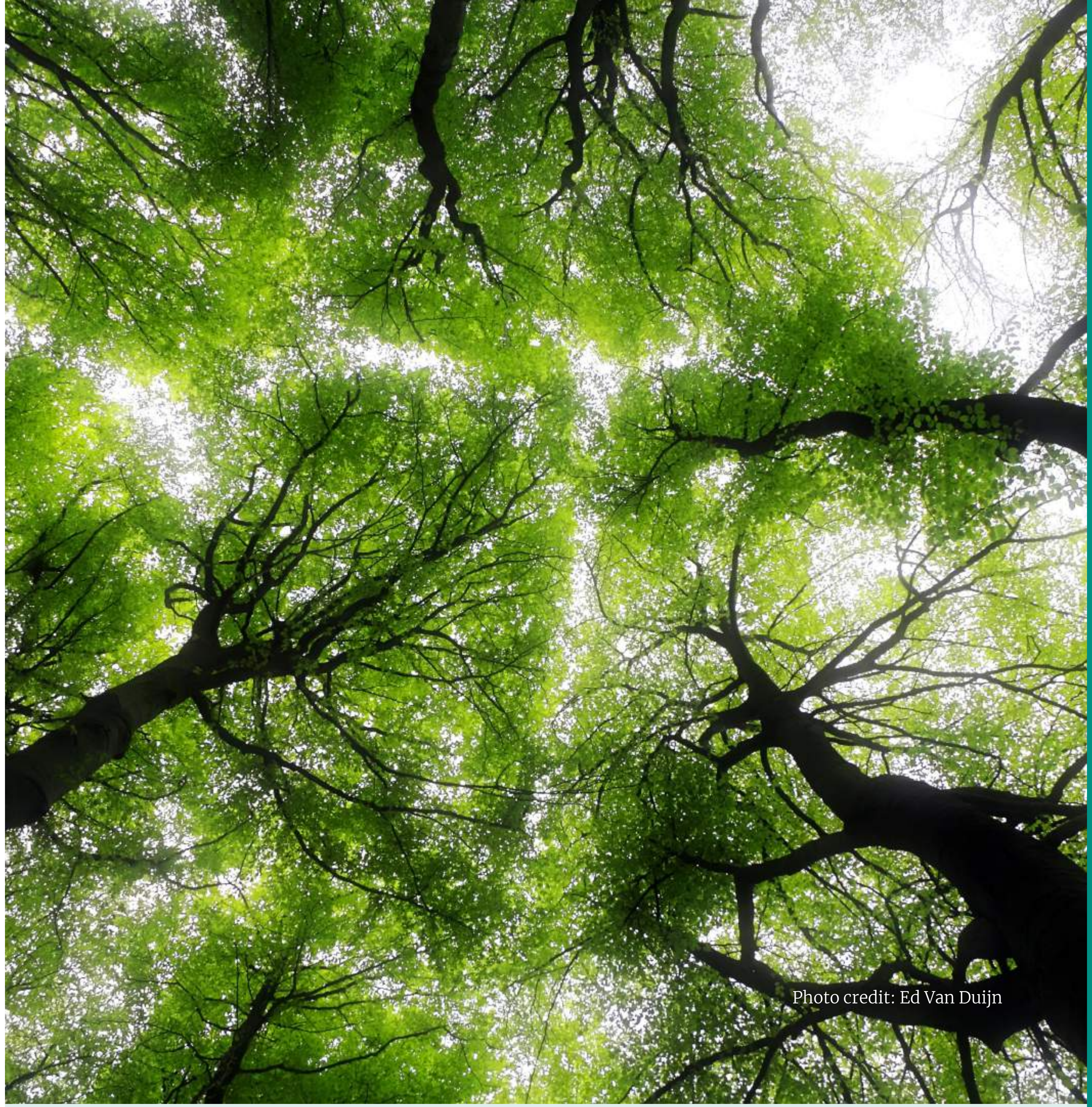
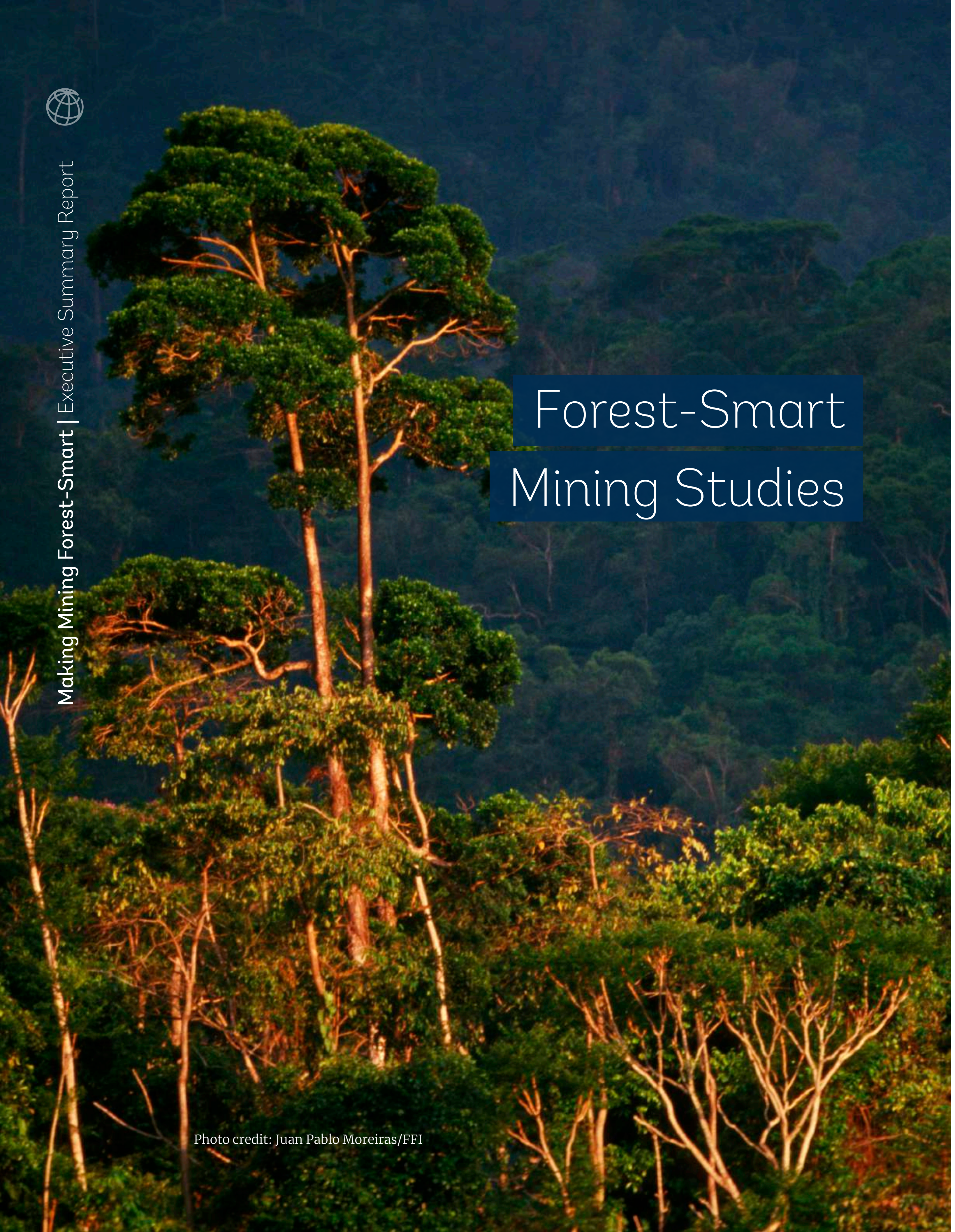


Photo credit: Ed Van Duijn

BOX 3

What Is "Forest Smart"?

The World Bank Program on Forests (PROFOR) defines "forest-smart" as "a development approach that recognizes forests' significance for sustaining growth across many sectors, including agriculture, energy, infrastructure, and water. It is sustainable and inclusive in nature, emphasizing that forests are part of a broader landscape and that changes in forest cover affect other land uses as well as the people living in that landscape. It transforms how sectors operate by identifying opportunities for mutual benefit and creating practical solutions that can be implemented at scale" (PROFOR 2016).



Forest-Smart Mining Studies

Photo credit: Juan Pablo Moreiras/FFI

RATIONALE AND APPROACH

The World Bank program on "Extractive Industries in Forest Landscapes" aims to ensure that the mining sector does not erode forest capital, but rather enables client countries and the World Bank Group to make better-informed decisions about minimizing trade-offs and maximizing benefits from "forest-smart" mining.

Two studies were undertaken between April 2017 and June 2018 to (a) determine the prevalence of mining in forests globally,* (b) improve understanding of the impacts of mining for forests and forest-dependent people, and (c) establish what a forest-smart approach to mining might look like and the extent to which examples and enabling policy responses already exist. For the purpose of the studies, the mining sector—which ranges from artisanal to large-scale 'industrial' mining—was considered in two broad categories: artisanal and small-scale mining (ASM) and large-scale mining (LSM) (Box 4). A third study explored the challenges of implementing biodiversity offset schemes to compensate for residual impacts of mining on forests and their potential to contribute to forest-smart approaches. In combination, these studies have identified the first known lessons learned for implementing a forest-smart approach to mining.

METHODS

The ASM and LSM studies focused on the metals and precious minerals mining subsector and did not include coal mining, industrial minerals mining, or quarrying. The prevalence of mining in forests globally and the health of forests in select landscapes were mapped and quantified by analyzing combined databases on forests, mineralization, and mining.** In total, 52 forested landscapes with mining activity were selected, representing a range of geographies, forest ecologies, mine types, and political and governance contexts.

* The definition of what constitutes a forest varies according to whether forest is seen in ecological, economic, political, or cultural terms, with more than 1,500 definitions documented (Chao 2012). For the purposes of these studies, the FAO definition of forests was adopted because it is the definition for which data are most readily available.

** Based on data from the Raw Materials Database (RMD), which includes information on almost all the world's LSM operations, including their geographical location, commencement date, and mineral production. The presence of mines in forest areas was determined by overlaying mine locations on a data set conforming to the FAO definition of forests.

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BOX 4

From Artisanal to Large-Scale Mining

The minerals sector is diverse in terms of mine size and technical operation and operates along a continuum from artisanal mining, to small- and medium-scale mining, to large-scale "industrial" mining. **Artisanal mining** is typified as formal, informal, or illegal mining operations, with individuals or groups of people using predominantly rudimentary technologies. **Small-scale mining** operations can also be mechanized, or semi-mechanized, and/or have a greater degree of capitalization than artisanal mining. Together, these are referred to as artisanal and small-scale mining (ASM) (OECD 2016). Minerals ranging from sand and construction materials to valuable metals and gems are mined artisanally, with gold the principal target mineral for ASM globally. Estimates suggest that ASM provides direct employment for some 40.5 million people in over 80 countries, and livelihoods for 150 million people (IGF 2017). Much of the ASM sector is informal (meaning miners do not possess required license/s to operate), with an estimated 75 to 80 percent being unregulated and unpermitted. In some contexts, ASM may be associated with illicit trade and crime. In some countries, acquiring a small-scale mining license requires an environmental management plan.

Large-scale mining (LSM) is typically a formal and regulated activity requiring licenses for exploration and mining that are subject to the completion of an environmental (and social) impact assessment (EIA/ESIA) and environmental management plan. LSM involves the use of industrial-scale technologies to extract and process valuable ore from

Large-scale mining activity.
Photo credit: Nattanan

the ground and has associated manpower requirements and logistics to support this, as well as infrastructure requirements (power, water, roads, rail, ports, pipelines, and so on). LSM targets a wide range of mineral resources where they occur in commercial concentrations, including those of relatively low value where economies of scale make the exploitation profitable (such as for coal and iron ore). LSM is a significant contributor to GDP in some countries.

Artisanal alluvial mining in Mongolia.
Photo credit: Jennifer Hinton

Semi-mechanized small-scale surface mining in Bolivia.
Photo credit: Manuel Salinas

Large-scale mining in tropical forest
Photo credit: Pippa Howard/FFI

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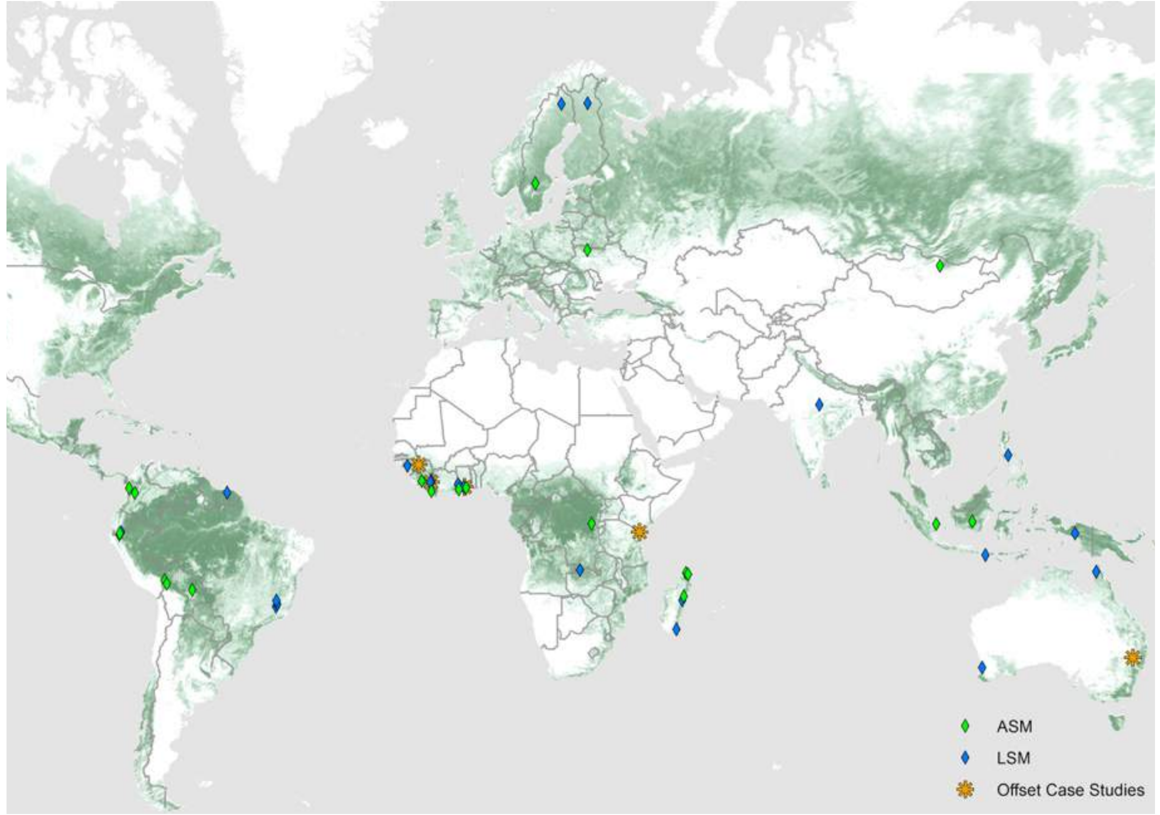
Photo credit: Kazuend

For ASM sites, the relative severity of forest impacts was assessed within a 5-kilometer radius. For both ASM and LSM sites, a forest health index consisting of 12 variables (for example, forest connectivity, density of roads, and people) was applied within an area of interest* defined by a 50-kilometer radius and river basin geography. To complement quantitative analyses, a subset of sites (Figure 3) were the focus of in-depth literature reviews, interviews, and, in some cases, site visits to explore potential factors influencing forest health and to identify good and bad practices for forest-smart mining and the conditions, mechanisms, and policy responses driving these. Challenges and opportunities for biodiversity offsets were examined through in-depth case study analysis at five sites (Figure 3).

Figure 3
Location of Focal Forest Landscapes



* The area of interest calculations were based on published data on the distances over which mines can cause impacts combined with the geography of river basins, which can be a key determinant of impact zones. They represented areas over which a mine site was likely to be one of the factors driving negative impacts and/or the area of which the mine could be having a positive impact if so desired.

Global Assessment Results

Photo credit: Juan Pablo Moreiras/FFI

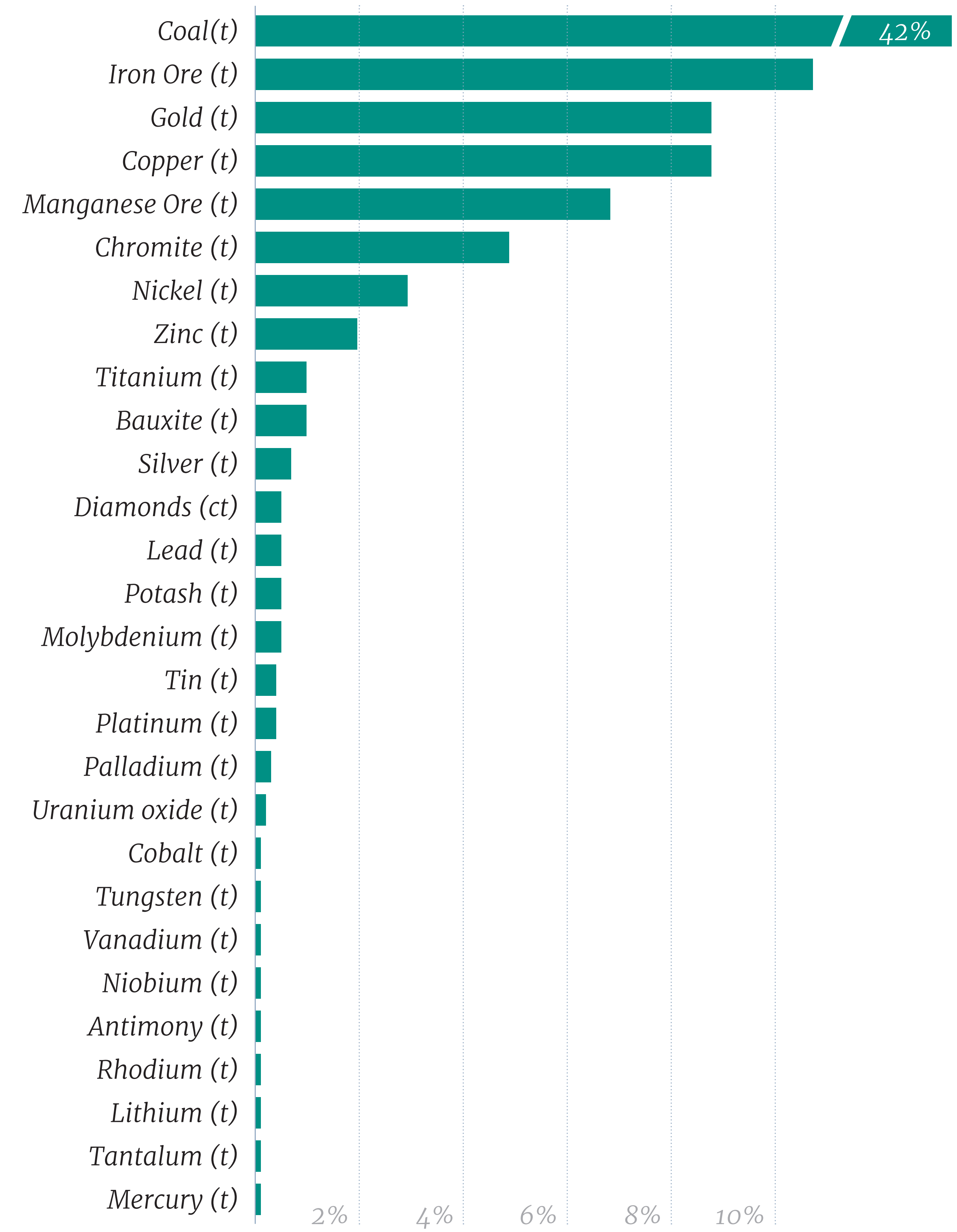
Photo credit: Rupert Cook

Distribution and Importance of the Metals and Minerals Sector Globally

The latest available data from the Raw Materials Database (RMD) include a total of 5,629 large-scale mines, most for metals and precious minerals.* In 2014, total gross value of production of these mines was about $1.4 trillion, dominated by a relatively small number of commodities, including iron ore, gold, copper, manganese, and chromite (Figure 4). ASM tends to focus on high-value easily accessible resources in small or large deposits, including the so-called conflict minerals (tungsten, tantalum, tin, and gold, or "3TG") and precious stones (diamonds, emeralds, sapphires or rubies), as well as industrial minerals (cobalt, copper, rare earth) and low-value commodities (mica, sand, limestone, or coal). ASM is most common in low- and middle-income countries, where it can account for the majority of mining sector activity when considering the numbers of people involved. For example, in Madagascar an estimated 500,000 people work in ASM, with a further 2.5 million people estimated to be dependents of ASM (IGF 2017). ASM is expanding in some countries and becoming more mechanized. The links between ASM and LSM can sometimes be strong, and in less developed countries ASM and LSM activities frequently and increasingly occur together.

* Coal mining and industrial minerals mining and quarrying are also included in the database but were not considered further in this study.

Figure 4
Total Gross Production Value of the Most Valuable Commodities, 2014



Sources: Raw Materials Database; Reichl, Schatz, and Zsak 2016; InfoMine website.

Mining in Forests Today

Mining in forests occurs across the globe, and in 2015 1,539 large-scale mines in the RMD—almost half of all operational mines—were operating in forest landscapes (Figure 5). A further 1,826 were in development or non-operational. More than half of large-scale forest mines are in low- or lower-middle-income countries, and three-quarters are in World Bank client countries.

Most forest mining occurs in some of the biggest mineral-producing countries, such as China, the Russian Federation, and the United States. However, the top 10 **priority countries for forest mining attention are Brazil, the Democratic Republic of Congo (DRC), Zambia, Ghana, Zimbabwe**, **the Philippines, China, Indonesia, Albania, and Russia** (Figure 5), where there is high forest cover, high economic dependence on mining, a high density of mines in forest areas, and forest degradation and loss is an important contributor to national greenhouse gas emissions. The top three minerals mined by large-scale operators in forests are gold, iron ore, and copper, while the **industries for bauxite, titanium, and nickel have the highest reliance on forest mines** (Figure 6).

Figure 5
Global Distribution of Large-Scale Operational Mines in Forest Areas (MFAs)

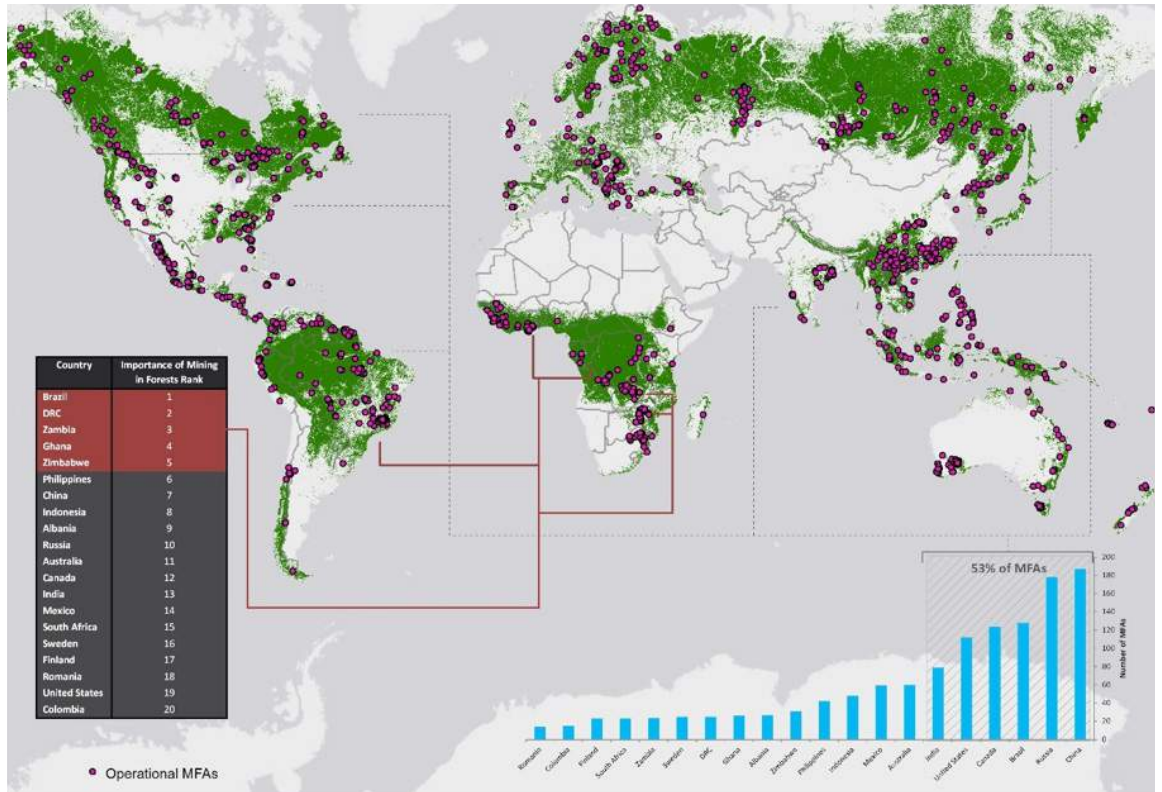


Figure 6
Global Distribution of Large-Scale Mines in Forest Areas (MFAs) by Mineral Type

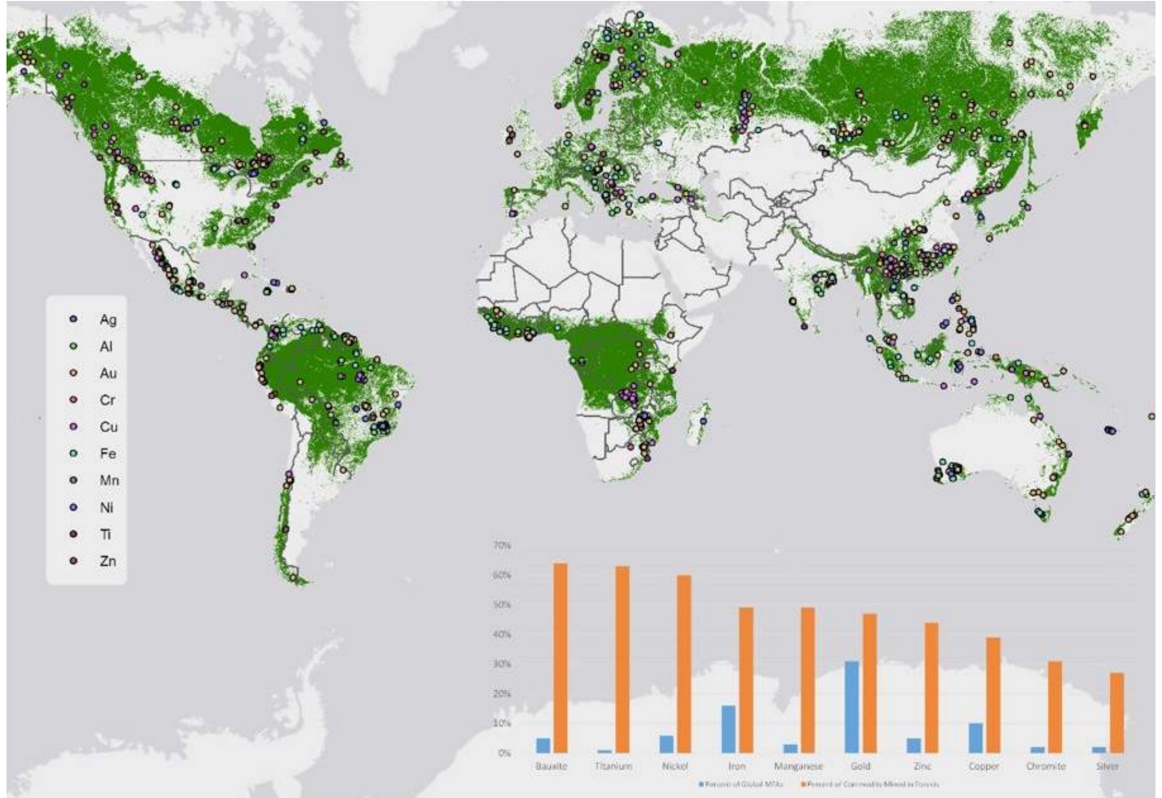


Figure 7
Intact Forest Landscapes, Tree Canopy Cover, and Known Deposits of Gold, Gems, Diamonds, Columbium (Niobium), Tantalum

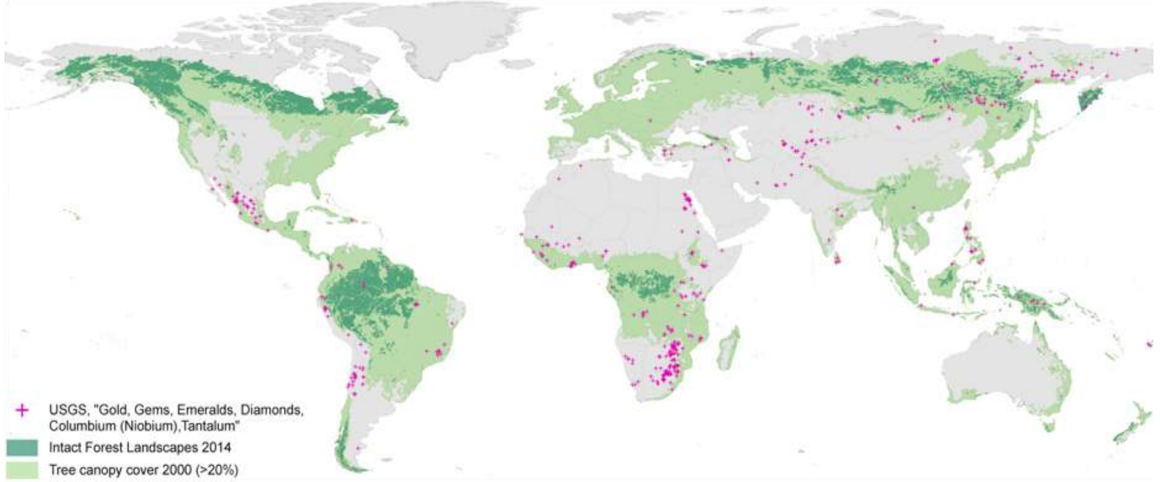


Figure 7 shows the occurrence of major deposits of gold, gems, diamonds, columbium (niobium) and tantalum as proxies for areas of potential ASM activity in low- and middle-income countries, in combination with global forests and intact forest landscapes. Note that, unlike for LSM, no global spatial data set of ASM mines exists; therefore, this figure only shows an indication of where ASM hotspots could be expected.

The location of ASM is driven by poverty, geology and the presence of mineralization (Figure 7). Despite overlap between major deposits of gold, gemstones and columbite (as proxies for potential ASM activity) and large forest areas, there is no evidence that ASM actively targets forest areas.

Many of the major mining companies are operating in forest areas, though the proportion of each company's mining portfolio that occurs in forests varies considerably (Table 1): of the parent companies included in the LSM study, Vale has the highest proportion of forest mines.

Table 1
Proportion of Mines Located in Forests by Company

Company	% of mines in forest areas within portfolio
Vale	92
UC RUSAL	87
Alcoa	82
First Quantum Minerals	67
ArcelorMittal	57
Newmont Mining	28
Rio Tinto Group	27
Glencore	26
Barrick	20
Anglo American	18
BHP Billiton	13

Note: Table limited to companies included within the LSM study only.

Around 10 percent of the world's forests lie within 50 kilometers of existing LSMs, rising to nearly a third if mines in development or currently non-operational are considered. Evidence indicates that mines can exert influence at least this far (for example, Sonter et al. 2017). Notably, 7 percent of large-scale forest mines are in tropical rain forest biomes where biodiversity and carbon values are highest. While few LSMs exist inside protected areas or key biodiversity areas, a large number exist within 50 kilometers of such conservation areas (Figure 8).

Figure 8
Large-Scale Mines in Forest Areas (MFAs) Located in or Near Protected Areas

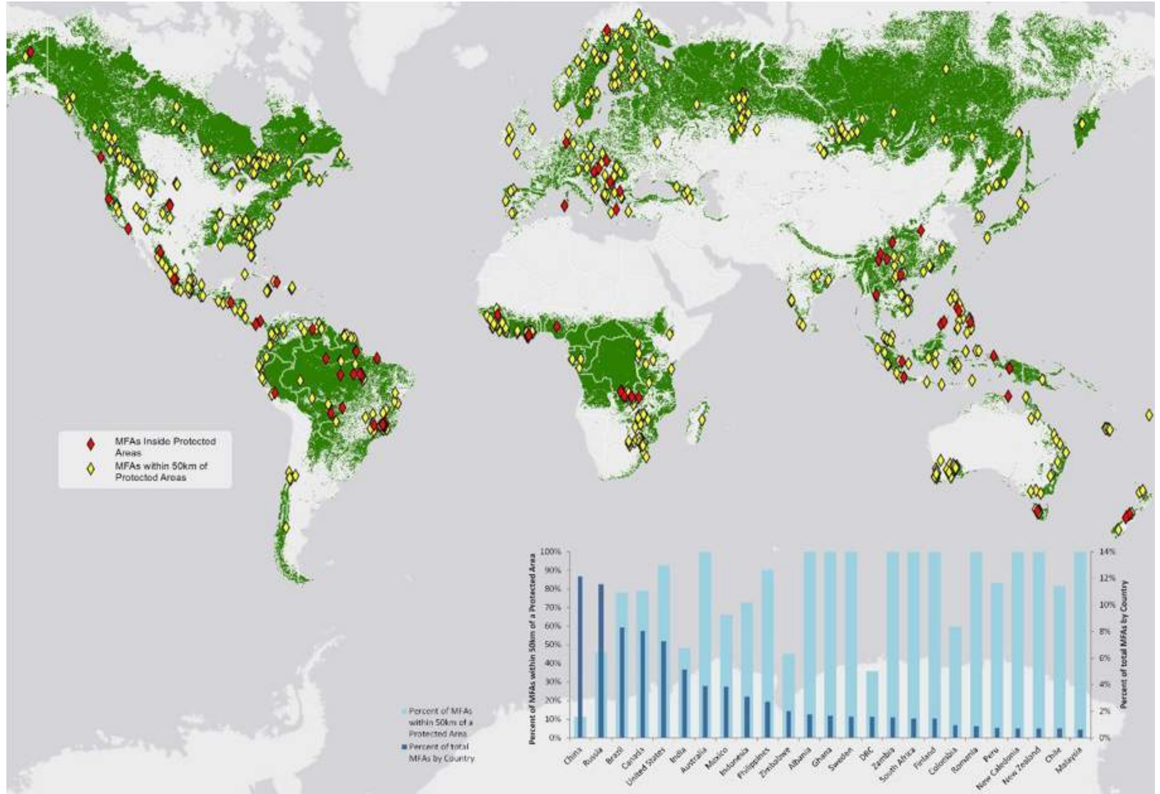



Photo credit: Angela Jorns/Levin Sources

Rise of Mining in Forest Areas

Given mining's economic significance, mining in forests is set to expand in economically, socially, and environmentally sensitive forest areas. An alarming observation of the work is that the number of new large-scale mines in forest areas commissioned yearly has increased from 4-10 during the 1980s to 20 or more in the last decade. Furthermore, most of the growth in LSM in forest areas is occurring in tropical regions (Box 5 and Figure 9).

Alongside growth in LSM in forests, an increasing number of mining projects are implementing biodiversity offsets to compensate for adverse impacts on forest habitats and species. These initiatives are driven as a result of companies' own polices, performance requirements from lenders, and public environmental policy. Recent analyses found evidence that most offset projects (associated with mining projects and other sectors) are being implemented in forests, with most in boreal, Mediterranean, temperate, and tropical forest biomes (Bull and Strange 2018).

ASM is primarily a poverty-driven activity that is strongly influenced by the price and demand for target commodities, political and economic instability, and employment opportunities, linked to the viability of climate sensitive livelihoods such as agriculture (Figure 10). ASM is expected to continue to respond to demand both for low-value min-

BOX 5

Mining Activity Is Increasing in Forest Landscapes in Sub-Saharan Africa

The Boké prefecture of northwestern Guinea contains some of the world's largest reserves of high-grade bauxite and the region is experiencing a rapid increase in LSM activity, with many new and very large concessions (up to 114,000 hectares) allocated, new green field projects, and the expansion of existing operations. Population influx is a major concern and associated with wide-ranging social and environmental impacts.

In Zambia, increases in the copper price coupled with a more enabling policy environment have led to reinvestment in exploration and project development in North-Western Province, which is seen to be the new copper belt. Extensive mining development has led to the loss and degradation of large areas of forests as a result of in-migration and infrastructure development.

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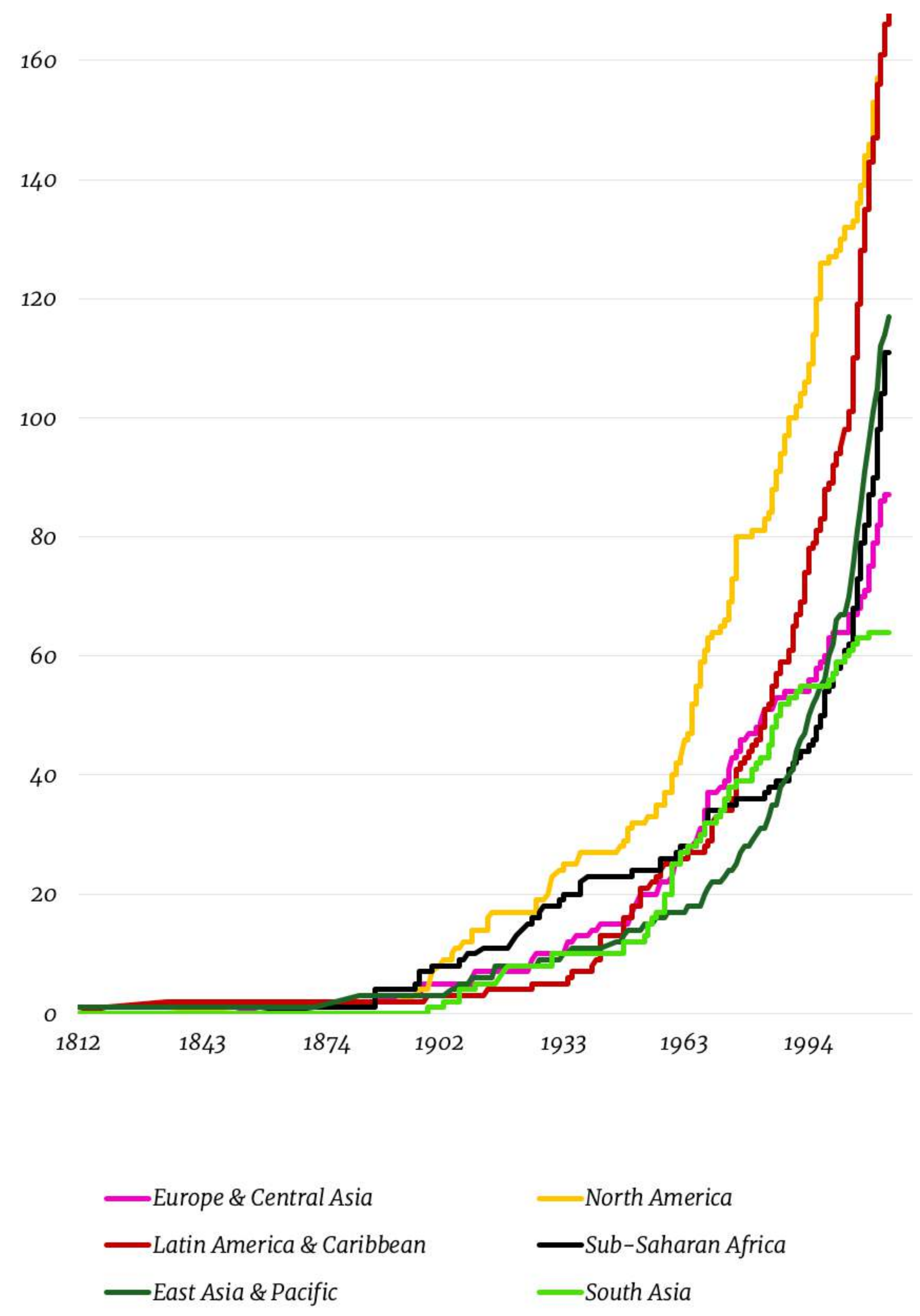
Figure 9
Comparison of Cumulative Forest Mine Opening Dates across Geographical Regions



erals used in domestic markets (such as construction) and high-value minerals as well as fluctuations in commodity prices. For example, rising demand for minerals such as cobalt and 3TG are expected to drive increased ASM activity in the Congo Basin, while increases in gold prices have been associated with the rise in mining-led deforestation in Amazonian forests.

ASM is increasingly the subject of public and private capital investment, resulting in a transition to more mechanized and destructive forms that can have significant implications for forest ecosystems (see Impacts of Mining on Forests). Whereas this was previously led by informal private capital, there are now diverse multimillion-dollar donor programs pursuing increased investment in ASM with a view to formalizing and/or introducing new technologies to reduce mercury emissions, many of which require upscaling, centralization, and mechanization of gold mining and processing.

Figure 10
Poverty, Employment Opportunities, and Climate Change Contribute to ASM Development

A lack of alternative employment opportunities and the impacts of climate change on rural livelihoods, such as agriculture, can be important factors in driving people to ASM, with many individuals and families embracing ASM to supplement their earnings. Photo credit: Asher Smith/Levin Sources

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Case Study Findings

Photo credit: Veeterzy

Impacts of Mining on Forests

While mining is rarely perceived to be the primary driver of landscape-scale deforestation, both LSM and ASM, alone and in combination, can adversely impact forests. Case studies illustrate the complex, wide-ranging, and potentially severe impacts of mining on forests.

Photo credit: Sebastian Grochowicz

SENSITIVITY OF FORESTS TO THE IMPACTS OF MINING

The studies show that **mining can be associated with anything from undetectable to very significant deforestation at a landscape scale** (Figure 11 and Figure 12). Yet case studies also emphasize the importance of looking beyond deforestation as a measure of impact because the implications of mining for forests can be complex and are often not detectable through satellite imagery (for example, disturbance of forest species, changes in forest structure and function, illegal wildlife trade, contamination of soil and water, loss of cultural values).

Figure 11
Deforestation Impacts of Mining and Associated Infrastructure

Photo credit: top left - Jeremy Holden/FFI; center left -Bannafarsai; bottom left - Manuel Salinas; right - Pippa Howard/FFI

BOX 6

The Multiple Values of Forests Are Often Underappreciated

Case studies highlight the reliance of local community stakeholders in low- and middle-income countries on forests for fuel, timber, charcoal, bushmeat, medicinal plants, and a range of other services, many of which are difficult to quantify economically yet hold immense value. These include cultural values (for example, sacred forests and genie residences linked to trees in northwest Guinea; in Kono District of Sierra Leone, the sacred bush is an important aspect of animist culture) and various supporting or regulating services, such as water provision, watershed management, flood control, carbon sequestration, soil fertility, local climate regulation, and resilience. For example, forests are an important safety net for rural communities in times of economic and other stresses. Even if people do not rely primarily on services from forests, the option to fall back on them in times of crop failure, commodity price crashes, or weather shocks can be important in certain circumstances (Wunder et al. 2014; Noack et al. 2015; Angelsen and Dokken 2015). Even where forests are highly degraded, the value of remaining forests to community stakeholders can be high.

Yet the multiple values of forests are often underappreciated, and the perceived economic value of mining is almost always higher than the perceived value of any forest. Forests remain unintegrated into sustainable development policies, and national policies often underestimate the true economic value of protected forests (for example, when forestry policies are production oriented). The irreplaceable nature of some forest values—including certain biodiversity, ecological processes, and ecosystem service values—is also often not recognized and the challenges and time frames associated with restoration may be poorly understood.

Photo credit: Jeremy Holden/FFI

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Forest habitats and species are particularly sensitive to the effects of mining and associated linear infrastructure and in-migration. For example, edge-related changes in forest structure, microclimate, and forest dynamics have been observed near linear clearings in the Amazon, the Caribbean, and tropical Australia (Laurance, Goosem, and Laurance 2009). The socioecological relationships between people and forests are also complex (Box 6) and highly sensitive to the environmental impacts of mining on forests.

Figure 12
Location and Extent of Mining Activities and Deforestation in Three Forested Landscapes

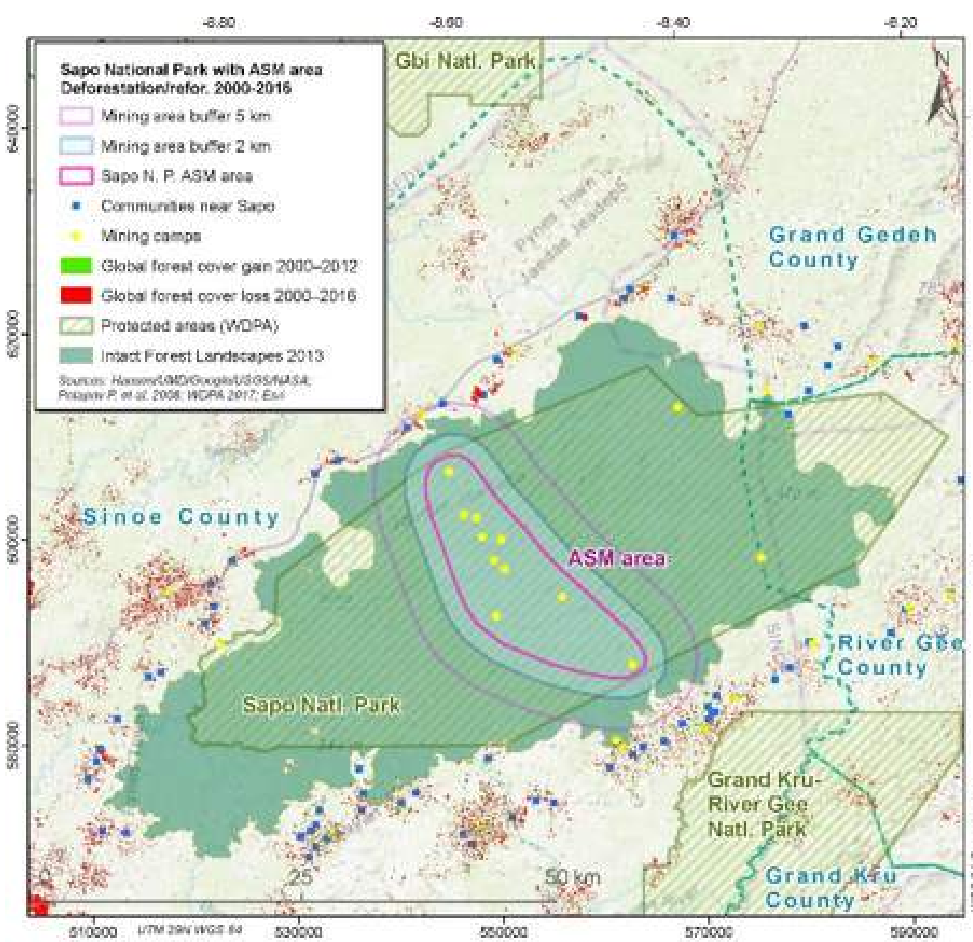
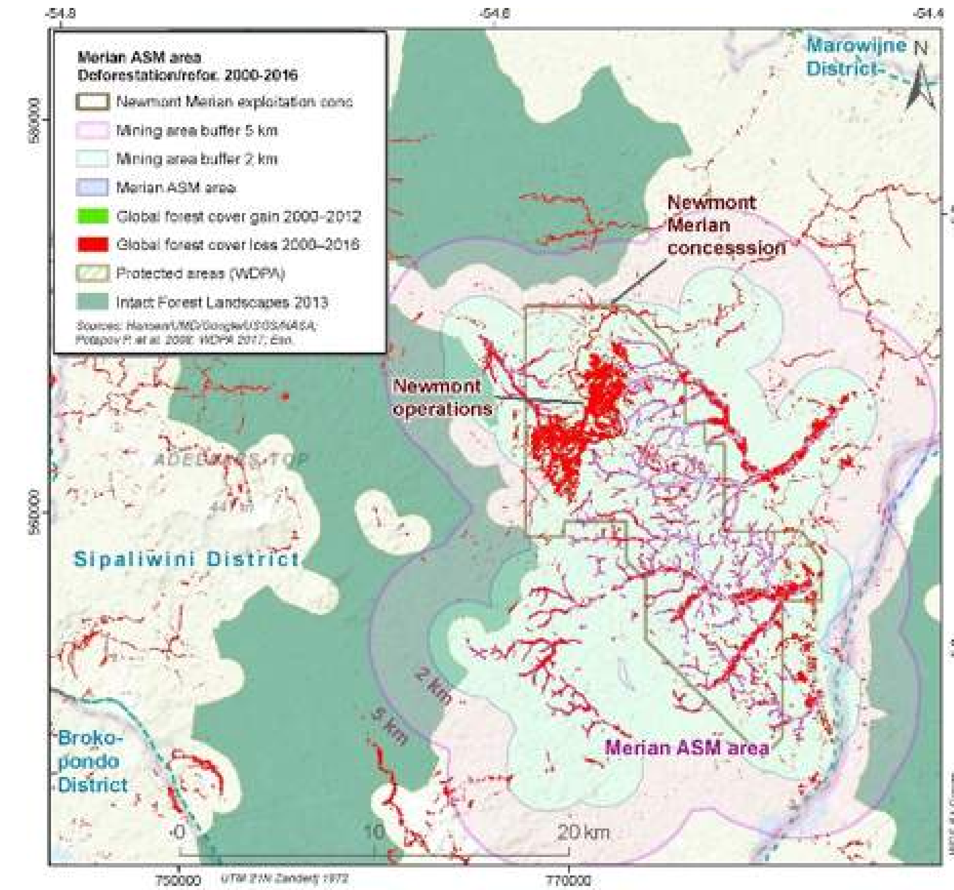
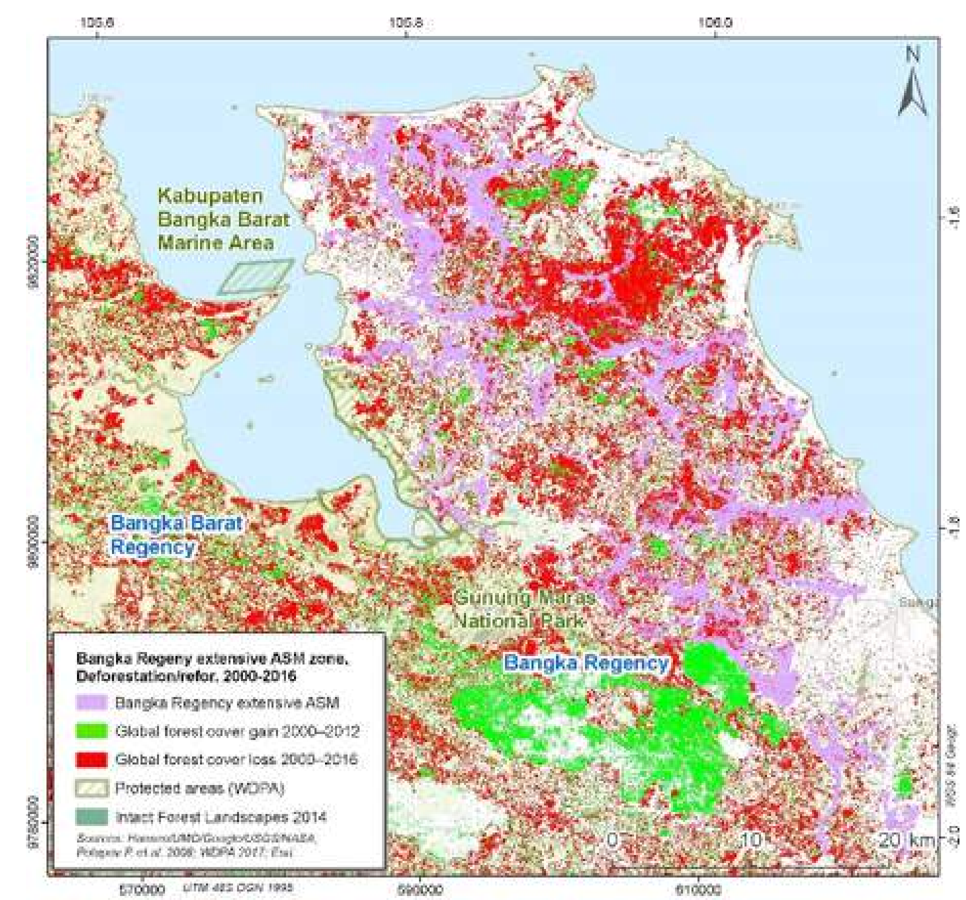


Figure 12 illustrates highly variable deforestation impacts (in red) in forest landscapes with mining activity. This page: Sapo National Park in Liberia, where ASM is taking place with minimal deforestation impacts; next page, top map: in and around Merian in Suriname, LSM and ASM activities co-occur with deforestation impacts evident at mine sites and in the surrounding landscape; next page, bottom map: at Bangka in Indonesia, there has been extensive mining-led deforestation across the landscape.





BOX 7

Mining Can Drive Landscape-Scale Forest Impacts

In Zambia, the footprint of First Quantum Mineral's Kalumbila mine is 10,000 hectares (UN-REDD Programme 2017), extending to 16,000 hectares in the mine plan, while in Suriname, Newmont's new Merian open-pit gold mine is situated in a densely forested area and its establishment has led to the direct clearing of approximately 5,000 hectares of forest, a noticeable impact even at the landscape level. Large-scale accidents, such as the catastrophic collapse of the BHP Billiton and Vale tailings dams in Brazil (2015, 2019) and the Marcopper Mining Corporation disaster in the Philippines in the 1990s (involving a tailings dam collapse and fracturing of a drainage tunnel between the Mount Taipan pit and the Boar River), have led to massive immediate and long-lasting impacts on communities and vast areas of forest and non-forest habitat. Disposal of mining waste can also have major local impacts. The Freeport-McMoRan Grasberg mine in Papua, Indonesia, has legally caused 13,800 hectares of forest loss so far, an area more than 42 times larger than the mine itself (Alonzo, Van Den Hoek, and Ahmed 2016) as a result of waste disposal. Projected losses are estimated to be up to 23,000 hectares.

There are also notable cases in which ASM is driving extensive deforestation and forest degradation, owing in part to the spatial distribution and geological characteristics of deposits. On the islands of Bangka and Belitung in Indonesia, tin deposits are widespread at shallow surfaces across the island, attracting an estimated 58,200 miners. Artisanal mining of these large, accessible deposits is associated with high deforestation rates and extensive forest loss: an estimated 220,000 hectares of critical land have been impacted by mining activities, including mangroves.

Mining of tin deposits in Bangka and Belitung, Indonesia. Photo credit: Yayasan Tambuhak Sinta

A river of mud followed the tailings dam collapse in Minas Gerais state, Brazil.
Photo credit: Leonardo Mercon

Large-scale copper mine in tropical forest. Photo credit: Pippa Howard/FFI

At Polesia in Ukraine, the mining of extensive and continuous shallow amber deposits using a hydraulic method has resulted in severe deforestation across 6,000 to 10,000 hectares (Piechal 2017; Wendle 2017).

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DIRECT IMPACTS OF MINING ON FORESTS

Direct impacts of mining include the impacts of the extraction itself, physical and chemical waste disposal, social displacement, and the footprint of associated infrastructure. LSM can be a major contributor to deforestation in some landscapes as a result of having a large footprint, tailings dam failures, and implications of waste disposal; ASM has relatively minor direct impacts on forest loss, especially in remote areas, though there are notable exceptions (Box 7). The loss of forest cover contributes to the loss of constituent biodiversity and associated ecosystem services, impacts the lives and livelihoods of local communities dependent on these resources, and contributes to climate change (Box 8).

Mineral type, distribution, depth of deposit, and mining methods (for example, open pit or underground, manual or mechanized extraction) strongly influence the direct impacts of mining on forests (Figure 13). The severity and extent of ASM-led deforestation depends on the spatial distribution of the deposit and increases with scale and the degree of mechanization, with semi-mechanized operations being particularly destructive, especially when poorly regulated. ASM deposits are also often subjected to repeat mining, preventing or delaying rehabilitation and resulting in persistent effects, while the use of machinery enables miners to exhaust known deposits more rapidly, requiring faster access to new deposits.

BOX 8

Mining-Led Deforestation and Forest Degradation Contribute to Global Climate Change

Deforestation from mining-related land clearance can be a major contributor to greenhouse gas emissions over the life of a mine. At a national level, mining is thus contributing to emissions from forest loss in numerous countries and is a dominant direct driver of deforestation in some. For example, in Suriname, mining is responsible for 73 percent of total deforestation, with the majority attributed to ASM for gold (Crawford and Bliss 2017). National REDD+ plans almost ubiquitously mention mining as one of the drivers of deforestation, though in almost every case the national focus has been on emissions related to agriculture or forestry.

Figure 13
Mineral Type, Distribution, and Depth of Deposit Influence the Forest Impacts from Mining

In West and Central Africa, most iron ore deposits form raised mountains in the landscape that support important forest habitat. As a high-volume, low-value bulk mineral, iron ore requires larger and different infrastructure than some low-volume, high-value minerals, such as gold. The potential for significant impacts on sensitive forest ecosystems can therefore be high.
Photo credit: Jeremy Holden/FFI

Hard-rock deposits are frequently located in forested upland areas and are associated with higher forest impacts than the mining of historic and contemporary stream bed deposits (alluvial mining), which typically occurs in lowland areas where forests have already been cleared for agriculture.
Photo credit:
Andrew Cooke/Levin Sources

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Other direct impacts from mining include disturbance of riverine habitats, basic siltation from mis-management of tailings, and the release of heavy metals and toxins, including mercury and cyanide (Figure 14). The implications for air, soil, and water quality can often be more severe than deforestation, with **long-lasting impacts for the ecological integrity and health of forests**, affecting food webs and ecological relationships, and reducing forest resilience to stresses such as floods, climate change, and fragmentation.

Even where direct impacts of mining are relatively minor (compared to other sectors), they can be locally significant, particularly when they affect ecologically sensitive or protected forests, ecological corridors, or native forest remnants on which people depend for ecosystem services (Figure 15). Forest species are especially vulnerable to mining-related impacts such as fragmentation caused by linear infrastructure and forest clearing because they include many ecological specialists that avoid even narrow (less than 30 meters wide) clearings and forest edges, as well as other species that are susceptible to collisions with traffic or predation near roads. Noise and vibrations associated with mining activity can also modify species behavior and cause displacement from a much larger area than that directly affected by forest clearance and degradation.

Figure 14
ASM Impacts on Riverine Systems, Water Quality, and Human Health Can Be Severe

Photo credit: Asher Smith/Levin Sources

Figure 15
Direct Impacts of Mining Can Be Significant for Forest Species

In Madagascar, even small impacts of mining on ecologically sensitive primary forest can be serious because they can undermine habitat connectivity, water or soil quality, and the essential ecological functions that are critical for the survival of threatened species. Photo credit: David Havel

At Sapo National Park in Liberia, the decline in pygmy hippo populations and increase in elephant migrations are believed to be in part a result of mining activities. Photo credit: Jeremy Holden/FFI

INDIRECT AND INDUCED IMPACTS OF MINING ON FORESTS

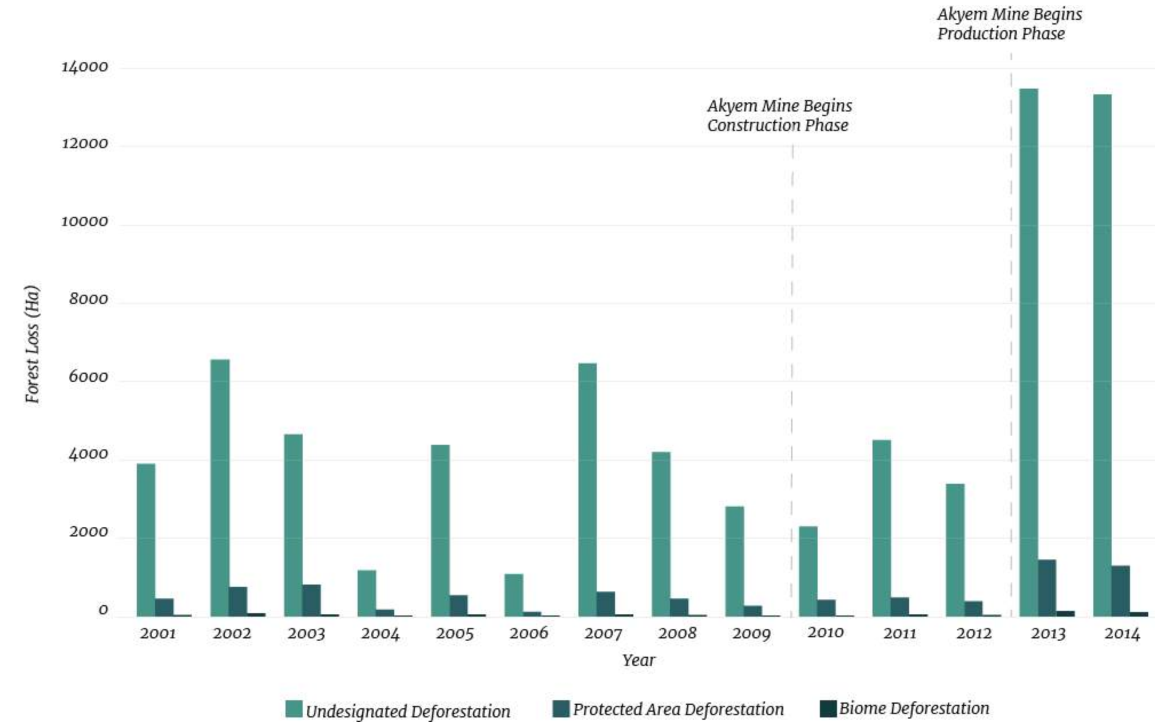
The **direct impacts of mining on forests are often dwarfed by far more wide-ranging and significant indirect impacts** associated with mining infrastructure and socioeconomic change (for example, the knock-on effects of people moving from the mine site and into the mining area, and of mining transport routes that improve access to forests). Many forest LSM sites are surrounded by large-scale forest losses, and in numerous cases there were notable spikes in deforestation around the time the mines were being developed (see, for example, Figure 16), likely associated with indirect or secondary impacts.

One of the most significant secondary impacts of mining is the influx of people (either through people moving into forest areas or forest clearance for agriculture to provide food to meet increased demand). This occurred in almost all LSM and many ASM sites. In-migration can disrupt traditional governance of land and resources, increase risks of conflict, undermine sustainable forest management, and contribute to forest degradation and loss. Around Grasberg in Indonesia, some 1.5 million people have reportedly moved into the region and downstream areas since 1970, causing major social upheaval and exacerbating riverine pollution. Around Ahafo in Ghana, many people moved to the area before construction and cleared land and planted crops to become eligible for compensation payments. Only LSM sites in the strongest economies and those employing the most modern, low-labor machinery managed to avoid population influxes (for example, LKAB's Mertainen mine in Sweden).

ASM case studies document rush situations, with significant numbers of people moving into an area in response to commodity price spikes or discovery of deposits, adversely impacting forests. In eastern Democratic Republic of Congo, an estimated 12,000 coltan miners moved into Kahuzi-Biega National Park in 2002 after an international price spike, clearing vegetation to access shallow deposits; whereas in Madagascar, some 45,000 miners moved into the Corridor Ankeniheny Zahamena area following the discovery of secondary ruby and sapphire deposits in 2016. Without strong coordination and government backing, the efforts by security forces, nongovernmental organizations (NGOs), local authorities, and community management organizations to manage such situations are often ineffective.

High road density is one of the key drivers of lower forest health at some LSM and ASM sites in Bolivia, Colombia, Guinea, Indonesia, Liberia, and Indonesia. **The expansion of roads and railways creates new or improved access routes into forests, often resulting in the degradation and decline of forest extent and condition as a result of people using the routes for access to land, bushmeat, fuelwood, timber, and medicinal plants** (Figure 17).

Figure 16
Regional Deforestation around Newmont's Akyem Mine in Ghana 2001–2014



Note: Deforestation data sourced from the Hansen Global Forest Loss data set; see full report for more details.

Figure 17
Linear Infrastructure Can Be a Major Contributor to Deforestation and Forest Degradation

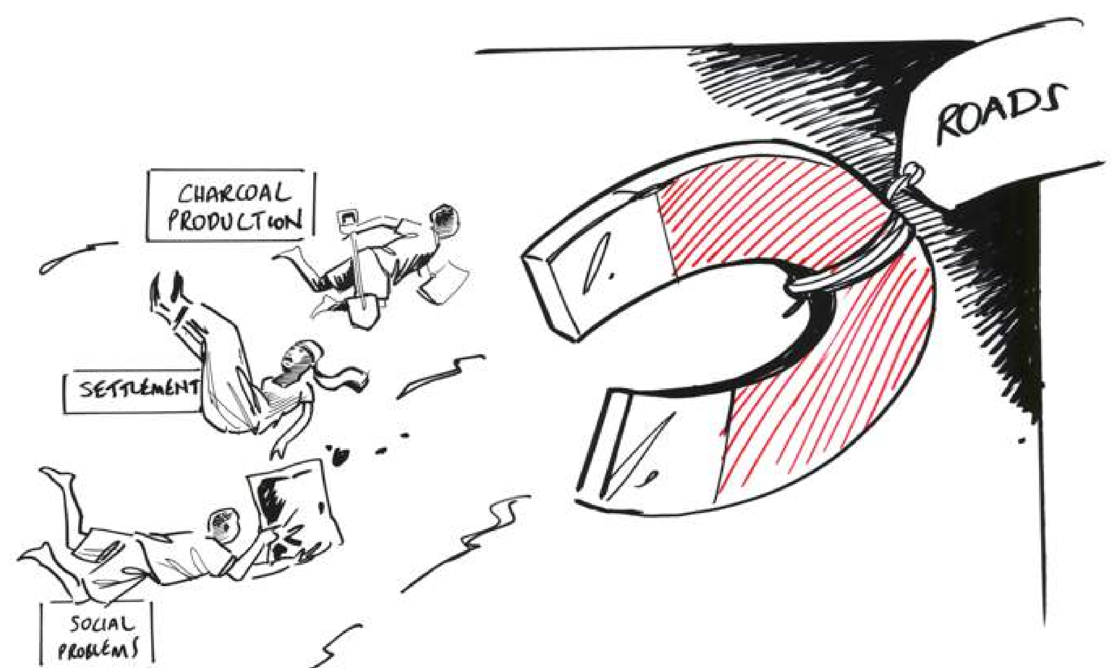


Image: Danny Burgess / FFI

A number of case studies in West and Central Africa point to a rise in hunting and wildlife trade linked to in-migration, improved access to forests, and the emergence of new markets for forest products (Figure 18). Roads may also facilitate illegal mining activity. For pioneer projects in intact and remote forest areas (for example, in Suriname and Ecuador) the impacts of road and rail development are a serious concern. Other indirect effects include **the impacts of displacement of people and contamination of agricultural lands, driving communities and agriculture into forests and protected areas** and impacts of price rises driving those not associated with the mine to forests for income.

Figure 18
Mining Can Drive Increases in Bushmeat Hunting and Trade

With food security a priority concern for many artisanal and small-scale miners, reliance on forest ecosystem services, including for bushmeat, is likely to be high. Impacts can be particularly severe in rush situations or when threatened species are targeted, such as gorillas in the Democratic Republic of Congo or chimpanzees in Guinea. Photo credit: Jeremy Holden/FFI

Photo credit: Bannafarsai

Indirect impacts from mining of all scales can reduce the ecological integrity of forests in a diffuse way. By fragmenting habitat, degrading riparian ecosystems, contaminating soils, or disturbing populations of endangered or sensitive species, mining can undermine forest structure and function, and overall resilience to external threats (Figure 19). Around the ASM area of Nambija in Ecuador, for example, although canopy cover remains largely unchanged, investigations have revealed changes in forest structure and composition. Therefore, forest health can be compromised through chronic rather than acute impacts on forest ecology.

Figure 19
Mining of All Scales Can Have Serious Impacts for Forest Ecosystems

Image: Danny Burgess / FFI

Mining impacts on the extent and condition of forests can have potentially serious implications for forest-dependent communities and the future well-being of countries through effects on the quality and supply of ecosystem goods and services. For example, there is increasing evidence that forests have a significant influence on local climatic conditions. Where forest loss (caused directly or indirectly by mining) adversely affects local climatic conditions (for example, less rainfall), exposes communities to higher risks (for example, increased risk of drought or flood), and impacts water-related services (for example, water quality and supply), there are likely to be significant impacts on subsistence.

Actions designed to mitigate mining impacts on ecosystems and communities may also lead to unintended indirect effects for forests and forest-dependent people in some cases (Box 9).

Photo credit: : Juan Pablo Moreiras/FFI

BOX 9

Unintended Consequences of Mitigation and Management Actions

There can be trade-offs between forest-smart mining and well-intended social management programs. For example, enabling access to new agricultural and pastoral lands through improving access routes and accessibility for in-migrants can result in unintended and unsustainable land development and forest conversion/loss, while rehabilitation designed to deliver direct use benefits to community stakeholders can have adverse implications for forests through the use of non-native species, some of which have proven to be invasive.

The design of forest protection measures, including biodiversity offset and REDD projects, may affect communities' access and use of forests. Not only can this disadvantage forest-dependent stakeholders, it may displace pressures (for example, hunting and harvesting, logging, clearance for agriculture, and so on) to other potentially more sensitive or high-value forest areas. **Understanding the full range of impacts for forest-dependent stakeholders and identifying potential trade-offs and synergies is critical.** In Liberia, the consultation period for ArcelorMittal's offsetting strategy took more than three years before all key stakeholders reached consensus, a process that has contributed to strategy success though poverty continues to drive infringements on the outcomes.

CUMULATIVE IMPACTS ON FORESTS

Where multiple mines operate in a landscape, the cumulative effects of mining can be considerable, impacting vast areas of forest and other ecosystems. A striking example is at Mount Tapian in the Philippines, where there was plenty of evidence of cumulative impacts of the Marcopper Mining Corporation operation, but no action was taken until it was too late, leading to a major accident when the tailings dam burst. The cumulative effects of prospecting and mining are also emphasized in the Boké landscape in Guinea, where increasing forest loss and fragmentation across large, adjacent LSM concessions is expected to exacerbate edge effects and put additional strain on sensitive and threatened species (Figure 20). Poor coordination and communication among different operators in the landscape can exacerbate cumulative impacts for forests and undermine forest-smart actions, hindering progress toward landscape-level objectives (Figure 21).

Cases like Bangka Belitung and Polesia illustrate the **potential for ASM activities to cumulatively impact vast areas of forest.** Conversely, where ASM is taking place in multi-use protected areas (for example, Madidi, Bolivia) mining at a low intensity may be compatible with protected area objectives under certain conditions, but it must be carefully monitored and managed to mitigate unintended cumulative effects.

Figure 20
Cumulative Impacts of Mining on Forest Habitat Can Leave Species with Nowhere to Go

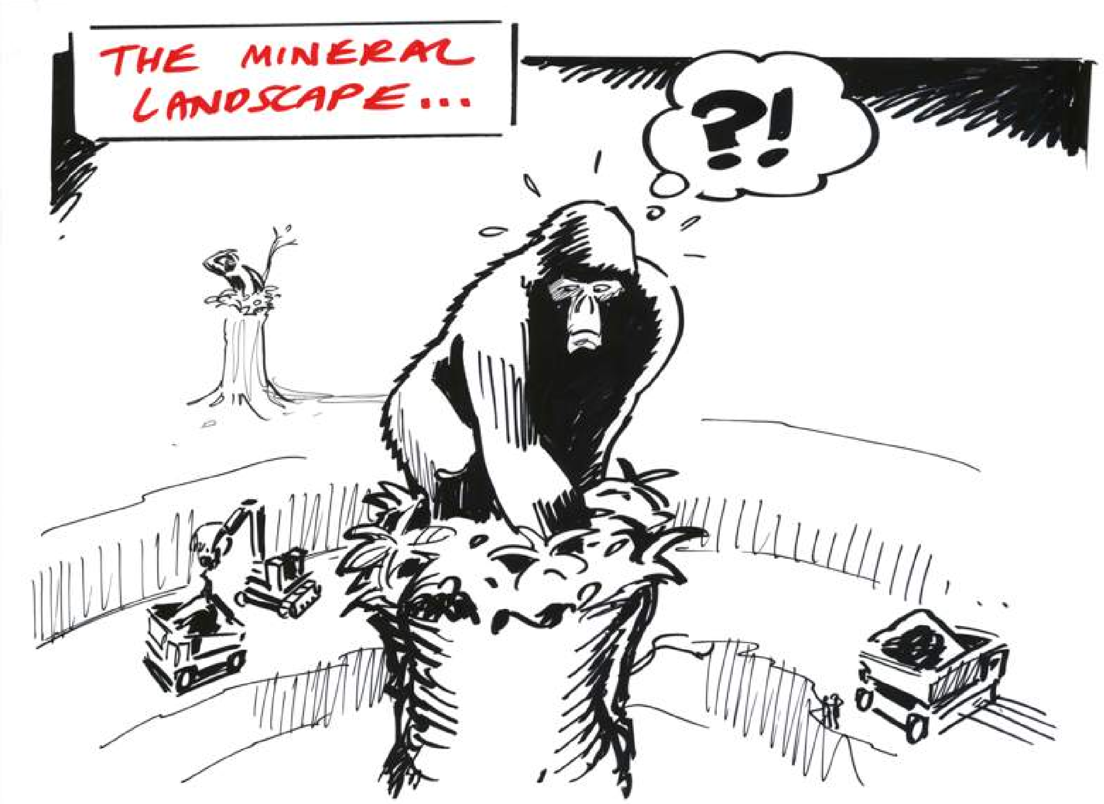


Image: Danny Burgess / FFI

Photo credit: Sebastian Pichler

When ASM and LSM share forest landscapes, evidence shows that negative forest impacts are often exacerbated and allocation of responsibilities for forest outcomes becomes more complex (Box 10).

Mining-led forest impacts can be particularly significant within the context of diverse and cumulative drivers of forest degradation and deforestation. The Iron Quadrangle in Brazil is under extreme pressure from urbanization, agriculture, forest exploitation, and water provisioning. The impacts of mining therefore must be considered within the context of other land uses and their cumulative effects. **In contexts where other industries are driving forest degradation and loss, forest-smart outcomes at landscape scale will depend on sectors, such as agriculture and logging, committing to addressing their impacts.**

Transboundary dynamics can further influence the cumulative effects of mining. The Nimba Range Mineral Province in West Africa, for example, can be considered a single entity geologically, ecologically, and even, to some degree, sociologically, but **political borders mean impacts in one area may be difficult to ascertain and control by actors in another jurisdiction.** Transboundary cooperation is critical to ensure that mining impacts on forests do not have transboundary effects and to address illegal trade in minerals, wildlife, and timber.

Figure 21
In Multi-Operator Landscapes, Poor Coordination Exacerbates Cumulative Impacts

Image: Danny Burgess / FFI

BOX 10

Forest Impacts Are Exacerbated in Landscapes Where Both LSM and ASM Are Present

LSM can act as an enabler of ASM by opening up previously inaccessible ecologically sensitive or high-value forest areas, exposing mineral deposits, or, in isolated cases, directly encouraging ASM as part of exploration. In San Luis, Ecuador, artisanal miners reportedly gained access to the Podocarpus National Park via roads constructed during LSM prospecting. ASM operators may also take over closed LSM mines and mining areas. **Planning decisions on where to allow the LSM sector to explore or mine can therefore strongly influence forest outcomes from ASM**.

The co-occurrence of ASM and LSM can lead to competition and conflict over mineral resources. In Tarkwa, Ghana, growing competition over gold-bearing land led to conflict between artisanal miners and LSM operators over concessions and increased illegal artisanal mining on LSM sites, protected areas, and agricultural land (Calys-Tagoe et al. 2015; Hilson and Potter 2005), exacerbating forest impacts both directly and indirectly (for example, by displacing agriculture). In Suriname, the eviction of ASM operators, by government initiative, to make room for LSM at Merian initially caused tensions and artisanal miners subsequently reentered the LSM concession. **Displacement of ASM can drive mining into more sensitive forest ecosystems and protected areas.**

In some landscapes, ASM activities are impacting the effectiveness of LSM social or environmental impact mitigation measures. At Bangka Belitung in Indonesia, for example, artisanal miners continue to undermine the state-owned company's rehabilitation efforts by re-mining areas abandoned by the LSM company. The situation is exacerbated because local law only requires reclamation after the resource has been completely exhausted.

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Context Matters

Collectively, the case studies provide a rich source of contextual variation at national and site levels. They encompass a range of ecological conditions and diverse forms of mining activity. Importantly, the case studies emphasize the importance of contextual conditions—particularly those relating to governance, socioeconomic and cultural aspects, landscape context and commercial parameters—in influencing the extent and severity of mining impacts on forests and delivery of forest-smart outcomes and pointed to common challenges and barriers as well as critical enabling conditions.

Photo credit: Juan Pablo Moreiras/FFI

GOVERNANCE

Strong and effective governance that manages the development and impacts of the mining sector, protects forest, and recognizes and protects local community tenure and rights is one of the most important enabling conditions for achieving forest-smart outcomes from mining and is critical for the long-term success of biodiversity offsets. The influence of policy and legislation, macropolitical and economic contexts, and tenure and rights over forests and forest resources are explored below.

POLICY AND LEGISLATIVE FRAMEWORKS AND THEIR APPLICATION

The importance of good governance is clearly demonstrated in countries with robust, stable, and coherent policy and legislative frameworks where implementing authorities have the necessary capacities and resourcing to apply the law effectively (for example, Sweden, Finland). A mature and stable legislative environment allows mining entities to plan for the long term, confident they will still be there and held accountable for their actions. Effective policies and regulation of ASM becomes increasingly critical as developing countries transition to higher income levels and financial capital and mechanization become more readily available to ASM operations. Strong governance that secures the long-term legal protection of forests was also shown to help limit the impacts of mining while providing companies with a sufficient degree of certainty to invest in biodiversity offsets and assuring civil society that these offset areas will not be eroded in the future.

However, strong legislative frameworks alone do not necessarily result in effective governance. A strong legal framework is, for example, of little use if most of the ASM sector operates informally and the problem is compounded when regulators lack the capacity to address or support artisanal and small-scale miners, often resulting in ASM being ignored or outlawed, in turn exacerbating impacts on forest. Failure to apply the law or to apply the law consistently is a major barrier and is often linked to institutional capacity and resourcing constraints, a lack of clarity over roles and responsibilities, power imbalances, and a lack of transparency (Box 11).

Weak governance can result in a failure to hold mining companies to account for their impacts, a failure to support artisanal and small-scale miners to mitigate their impacts, and/or a failure to protect forests from the impacts of mining. At the same time, opportunities to achieve long-lasting forest-smart outcomes or to scale up site-level conservation to achieve positive impacts in the wider landscape may be impeded. Implementing offsets, for example, is highly challenging in countries with a weak or contradictory regulatory environment and where governance and planning processes are

Photo credit: Karsten Wurth

suboptimal in terms of conservation. The case studies demonstrate the implications of weak governance for forest impacts from mining and highlight challenges to the uptake of more forest-smart approaches (Box 11).

Poor coordination among ministries and between relevant government departments was observed in many of the case studies and was found to undermine effective governance, inhibit forest-smart approaches, and exacerbate challenges in identifying suitable offset options. In most cases, responsibility for mining and forests sits with different ministries, and often the department with responsibility for mining is significantly better resourced and influential. Consolidation of mining and forests within a single ministry alone is not a solution because the necessary coordination may still be lacking, as is the case in Ghana. Besides mining and forestry, there is also a need for greater interministerial cooperation with ministries responsible for other land uses, such as agriculture and infrastructure, and resources including energy and water.

Greater decentralization can promote more effective governance and support forest-smart mining when coupled with adequate capacity, resourcing, and coordination. Decentralization of authority can empower local government to take a more active role in promoting forest-smart mining, allowing for better land use planning and management of mining at a local level, where capacity exists to take on this responsibility. However, the case studies emphasize that this must be supported by adequate collaboration and coordination between different levels of administrative units, a clear understanding of respective roles and responsibility, and the effective integration of higher-level policy objectives and landscape-level planning.

BOX 11

Weak Governance Presents Challenges for Forest-Smart Mining

The case studies show that where **policy, regulation, and supporting guidance are immature, lacking, inconsistent, or unstable, this can inhibit forest-smart mining and exacerbate impacts on forests:**

- Very often **forest policy conflicts with minerals policy,** and environment policy is often weak, or within a weakened ministry. In Ghana, competing demands on land and resources have led to a lack of coherence between forest law and other laws and policies to achieve the protection of biodiversity values.
- **Duplicative, overlapping, or contradictory legal texts** and gaps in implementing regulations governing forests, natural resources, and mining risk forcing out companies that are subject to international scrutiny and standards, and companies that are not subject to the same pressures may then replace them.
- **Inadequate ESIA legislation:** In many cases, ESIA legislation exists but may not be keeping up with current best practice (for example, requiring systematic application of the mitigation hierarchy). In rare cases, there is no ESIA legislation—such as in Suriname, where legislation is still nascent—and while legal reforms are ongoing, there is currently no environmental authority and EIA/ESIA guidelines are not law, despite the development of LSM sites. This makes it difficult to enforce environmental norms and conservation measures.
- **Legislation that does not adequately differentiate different scales of mining and ill-adapted regulations can exacerbate the impacts of ASM on forests.** In Ecuador, cooperative members perceive environmental requirements for small-scale miners under the new Mining Law of 2009 too onerous for their scale and capacity, risking noncompliance.

Failure to apply the law, and apply it consistently, undermines and inhibits forest-smart mining:

- **Poor institutional coordination and weak law enforcement** in Madagascar, coupled with a largely informal mining sector and a lack of good governance, lead to a situation where illegal mining in protected areas and high deforestation rates persist.
- At Bangka Belitung, Indonesia, **regulatory, capacity, and transparency barriers** are combined with a population base prone to the pull factors of ASM and an extensive geology of high-value and accessible deposits with severe implications for forest ecosystems.
- **Unclear legislation, poor enforcement, and limited budgets for environmental education** constitute major barriers to effective governance in Central Kalimantan, Indonesia, where authorities struggle to control the artisanal gold sector and its impacts on forest health.
- In Colombia, a **lack of clarity over permissible activities** within each forest designation, **inadequate government presence** in remote but mineral- and forest-rich areas, and **confusion over the mandates of different mining entities,** constrains application of laws and policies for managing mining in forests.
- Some countries have introduced special zones reserved for ASM, with the aim of improving management of the sector and avoiding impacts on sensitive areas. Case studies in the Democratic Republic of Congo and Indonesia show that such designated **ASM areas are ineffective without active enforcement.**
- **Inadequate compliance monitoring and failure to hold companies accountable for noncompliance** is a major barrier to forest-smart mining. In the Ukraine, there is weak punishment for illegal amber extraction and no punishment for trade or use of illegal amber (Piechal 2017).

Weaknesses in governance lead to failures to protect forests from mining impacts:

- **Weak governance of protected areas** in Zambia is linked to outdated policy and legislative frameworks and capacity constraints, while in Ghana and Indonesia, protection of some forest areas has been weak, with the law adjusted or exemptions given to allow mining to proceed.
- **Forest law is circumvented for mining:** In Mongolia, the Long Name Law 2009 has legal leverage in protecting the forested headwaters of many river basins, yet it is frequently circumvented.
- **Weak financial due diligence may allow for impacts** on forests through the development of financially unviable mining projects (for example, LKAB's Mertainen mine in Sweden).
- **Disputes over jurisdiction and excessive decentralization can create challenges for strategic landscape planning:** In Indonesia, government is increasingly decentralized, yet in some areas, such as Central Kalimantan, this has led to disputes over jurisdiction of forest zones, creating challenges for land use planning. Excessive decentralization also risks delivery of higher policy objectives and application of strategic landscape approaches.

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BOX 11 (CONT.)

- **Forest values are underestimated and may be considered substitutable with mineral values,** while the long-term implications of mining on other forest values, including biodiversity, ecosystem services, and community livelihoods, is poorly understood.
- **Irreplaceable forest losses:** In Sweden, which achieves forest-smartness in many respects, there has been a failure to prevent mining impacts on remaining areas of old-growth forests, impacts that cannot be fully compensated for through offsetting.
- Mining disasters in the Philippines and Brazil stress the **devastating consequences of governance failures** at the national and corporate levels.

MACROPOLITICAL AND ECONOMIC CONTEXT

Macropolitical and economic contexts have a strong influence on mining and forests. **Political instability, conflict, and crises can undermine effective governance and act as a major barrier to forest-smart mining, while political cycles within nations can cause mining and forest policies to fluctuate, oscillating with changes in government, and creating challenges for the long-term protection and sustainable management of forests.**

National commitment to REDD+* and pro-forest policies that balance the conservation of forests against the development of other sectors were associated with lower impacts on forests from mining. Notably, forest and protected areas policies and regulations were found to be stronger determinants of ASM impacts on forests than mining policy and regulation. Conversely, when mining and/or other sectors (for example, agriculture, forestry) are prioritized over forest protection, this can contribute to higher rates of deforestation from ASM, undermine forest-smart actions by mining operators, and present constraints on identifying suitable offsets and securing their long-term implementation (Box 12 and Figure 22).

* REDD+ refers to Reducing Emissions from Deforestation and Degradation, the "+" referring to sustainable management of forests, conservation of forest carbon stocks, and enhancement of forest carbon stocks.

BOX 12

Macropolitical and Economic Conditions Can Undermine or Impede Forest-Smart Mining

- **Political instability undermines forest-smart efforts** by companies in Madagascar, where changes in government and the subsequent lack of a consistent long-term vision continue to hamper the development of a landscape-level approach to mitigation by LSM operations.
- In Ukraine, a **complex political situation, ongoing conflict, and a recession** pose serious challenges for government and the control of illegal mining, leading to significant forest impacts.
- In countries such as the Democratic Republic of Congo, Colombia, and Liberia, **conflict and crises can be a driver of ASM in forests and hinder forest-smart mining** by undermining governance, effective regulation, or the success of forest conservation investments.
- In Bolivia, state **policy encourages agricultural expansion through legal conversion of forests,** resulting in large-scale landscape-wide conversion of forest lands for agriculture in some areas, presenting challenges for achieving forest-smart outcomes at the landscape scale.
- **More lucrative uses of land consistently eclipse offsets worldwide and increasingly offsets are being offset**. In Ghana, globally significant biodiversity areas identified as potential offset sites were developed for other purposes, including mining, as a result of inadequate protection and competing demands from other, more lucrative land uses.
- **Prioritization of agriculture constrains offset** options in parts of Australia, as offsets must not impact agricultural or pastural land uses. This complicates the task of acquiring and securing regionally significant areas of remnant vegetation to be managed for biodiversity conservation.
- **Environmental and Social Impact Assessment (ESIA) processes are often inadequate, nonfunctional, or compromised:** In some contexts, mining authorities are putting pressure on environmental authorities to streamline the ESIA process to minimize delays, and in many countries, there is a lack of government capacity to monitor and evaluate them. As a result, ESIAs for LSM are often inadequate (for example, giving scant attention to environmental impacts or missing entire sections on responses to impacts identified), not accessible in the public domain, or are conducted after mining project activities have started.

Figure 22
More Lucrative Land Uses, Including Mining, Increasingly Eclipse Offsets Worldwide

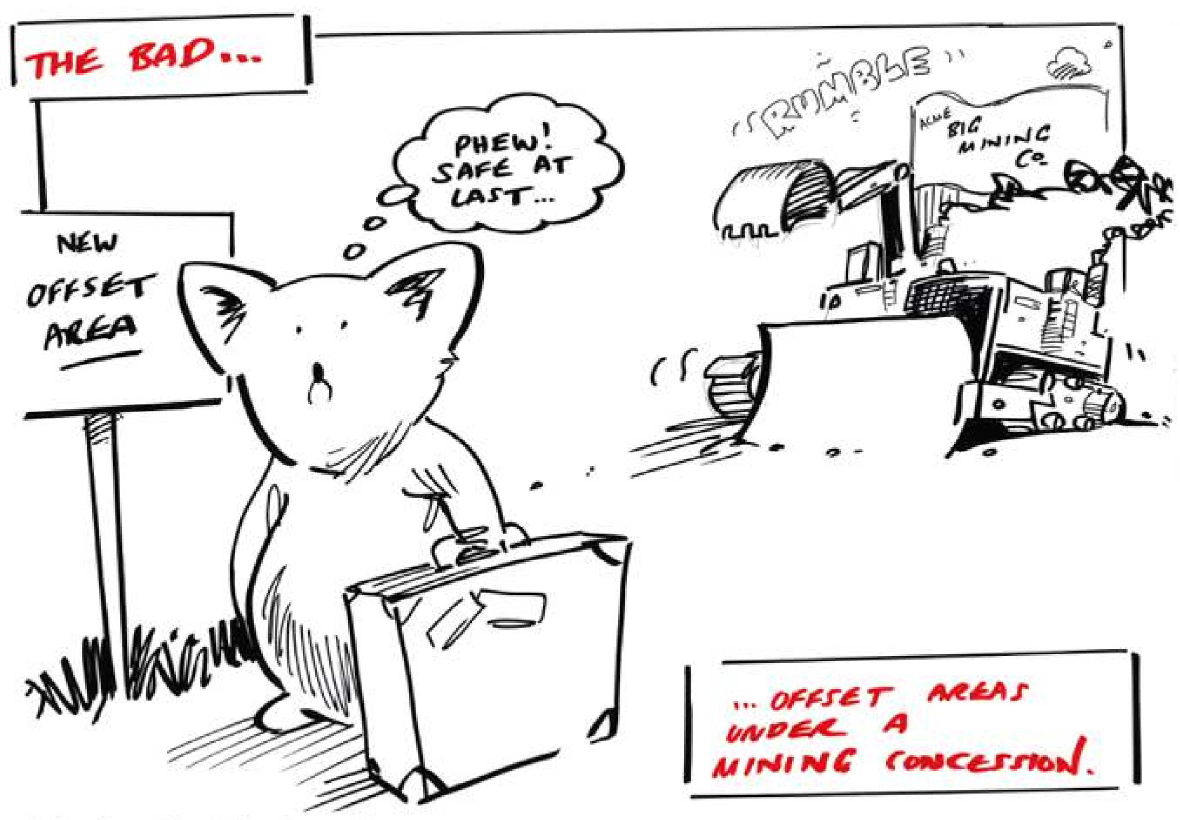

Image: Danny Burgess / FFI

TENURE AND RIGHTS

Tenure and rights over forests vary considerably and are strongly linked to the severity and extent of forest impacts from mining and the potential for sustainable forest outcomes.

ASM is occurring on land under state ownership, formal indigenous ownership, and mixed state and recognized customary ownership, as well as on legal mining concessions. The extent to which some form of permission is granted to miners varies (for example, in Central Kalimantan permissions range from official licenses to customary permits from local village cooperatives). LSM typically operates within legally allocated concessions, with the state granting rights for exploration and/or extraction to the company. State control allows for rights for exploration and mining to be provided over privately held land even in the case where the owner opposes such an activity.

In many countries, the **lack of clarity over land tenure and mine concession rights is a major issue that results in overlapping and conflicting rights.** Local community tenure over forests was also found to be absent, unclear, disputed, or unrecognized in law in many of the case studies, leading to underestimation of forest value, poor forest protection, and unsustainable resource use (Box 13). Legal reforms to clarify land tenure and establish processes for allocating natural resource use and access rights are under way in some contexts and needed in others. This must be coupled with a sound understanding of the respective roles and responsibilities and the capacity to fulfill them, particularly for state or communal land, to avoid "tragedy of the commons" scenarios, whereby no stakeholder has the mandate, interest, or ability to conserve or sustainably manage forests.

Strong property rights and land tenure systems that recognize both modern legal and customary rights are associated with lower impacts from mining on forests. They have also proven key ingredients in sustainable resource use and forest protection. In turn, this may help to build support for forest-smart actions and contribute to the success and sustainability of forest-smart mitigation measures.

The recognition and protection of indigenous rights can help prevent incursions from various industries and in-migration into forested lands under indigenous control. This is particularly evident where indigenous rights are formally respected through no-go commitments to indigenous territories or appropriate application of free, prior and informed consent (FPIC). However, issues around indigenous rights are complex and environmental safeguards remain important to mitigate the unsustainable exploitation of minerals.

Photo credit: Estelle Levin-Nally/Levin Sources

BOX 13

Unclear, Unrecognized, or Disputed Tenure Poses Challenges for Forest-Smart Mining

- **Unclear and disputed land tenure** is an overarching issue for Kahuzi-Biega National Park in the Democratic Republic of Congo, with many people exerting claims on park land; exercising rights to mine, farm, and hunt inside the park; and impacting conservation efforts.
- **Unclear land tenure enables in-migration,** and settlement around Kalumbila mine in Zambia has led to land use alteration, forest clearance, and wider associated socioeconomic impacts.
- Lack of a national land use plan in Liberia and poor coordination between sectors has resulted in **overlapping concessions** and concessions allocated in community and protected forests.
- Where customary rights are held over biodiverse and/or carbon-rich forests the **potential for conflict in establishing forest protection** or securing offset areas can be high. In Liberia, demarcation of the Gola Rainforest National Park sparked conflict over land rights. In Guinea, the success of the Moyen Bafing offset will depend on respecting the rights of communities.
- **Indigenous and other local community rights are not recognized in law** (for example, Suriname), presenting a significant barrier for forest-smart mining and increasing the risk of conflicts. Elsewhere, the integration of community land and natural resource rights into relevant policies and legislation is patchy and incomplete.
- In Mapiri, Bolivia, a growing number of in-migrants are believed to be involved in ASM on designated indigenous territories, **jeopardizing indigenous rights** to use renewable resources and receive a share of the profits from mining on their lands.
- In Chocó, Colombia, Afro-Colombian Community Councils get priority when requesting a special mining zone within their territory. This includes priority over forest protection, with **risks for the unsustainable exploitation of minerals in forests in the absence of environmental safeguards.**

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LOCAL SOCIAL, ECONOMIC, AND CULTURAL CONDITIONS

The case studies showcase the myriad ways in which people interact with, depend on, and value forests, as well as the diverse drivers for engaging in mining. This has implications for the severity and extent of mining impacts on forests. For example, in some contexts artisanal mining is giving way to more mechanized methods (Figure 23), **with increased prosperity (not poverty) driving higher forest impacts from ASM. Higher incomes, higher equality, and higher unemployment are found to be associated with *increased* impacts of ASM on forests. Illegal small-scale mining can be particularly destructive,** contributing to increased deforestation and biodiversity loss, contaminated rivers, and increased access to remote forest areas at some sites, such as Chocó, Colombia.

Figure 23
Impacts of ASM Increase with Mechanization

Photo credit: Manuel Salinas

The **socioeconomic context strongly influences the scale and severity of impacts from LSM on forests.** For example, the economic climate strongly influences the severity of indirect impacts from linear infrastructure: the most severe impacts typically occur in lower-income countries where the reliance of rural communities on forests is high (Figure 24), whereas in higher-income countries, such as Finland and Sweden, mining landscapes support healthy forests despite high road density.

Figure 24
Expansion of Roads and Railways Contributes to Forest Degradation and Loss

Photo credit: Juan Pablo Moreiras/FFI

Understanding local conditions can also help in identifying appropriate mitigation responses that maximize opportunities for forest-smart outcomes (Box 14). For example, ASM (particularly nonmechanized artisanal forms) is strongly associated with low levels of development, high degrees of poverty, subsistence lifestyles, and in some countries the presence of indigenous peoples or vulnerable communities. **The promotion of alternative livelihoods to ASM has proven challenging,** partly because of a lack of suitable alternatives that deliver tangible economic benefits and partly because earnings in mining are often significantly higher than in alternative livelihoods. Conflict and climate change can aggravate the problem by exacerbating poverty, limiting alternative livelihood opportunities, or by driving migration flows into remote and mineral-rich areas where few other economic alternatives exist.

A sound understanding of socioeconomic and cultural aspects can help LSM operators design locally appropriate mitigation. For example, **for biodiversity offsets to succeed, they must address community needs and provide realistic opportunities for alternative** livelihoods should restrictions be imposed on communities within the offset area (Figure 25). The case studies in Liberia and Guinea emphasize the importance of understanding the complex relationships between people and forests and ecological constraints on small-scale agriculture (that is, why farmers undertake certain practices). This is critical if socially, economically, and environmentally sustainable alternatives to damaging land use practices (for example, slash-and-burn agriculture) are to be identified. **Ensuring that the livelihoods and subsistence needs of communities are not adversely affected by actions to mitigate or compensate for LSM impacts is essential.**

BOX 14

Local Conditions Present Challenges and Opportunities for Forest-Smart Mitigation

- **ESIAs rarely consider how environmental impacts of mining also affect local communities,** typically taking a more siloed approach that considers how mine activities impact the environment *or* communities. More holistic approaches and ecosystem services assessments can help address this, as demonstrated by Newmont at its Ahafo mine in Ghana.
- **Mitigation planning fails to identify and manage trade-offs** between environmental, social, and climate aspects. For example, social management programs that focus on rehabilitation of impacted areas with fast-growing non-native timber and crop species risk the introduction of invasive alien species, threatening the long-term ecological function and stability of forests.
- An **understanding of local cultural norms and values** has informed impact mitigation in the Boké landscape in Guinea, with some companies supporting community forest management to protect important forest habitat and species and maintain cultural values.
- **Failure to deliver on promised alternatives** following ASM evictions erodes trust and can lead to recurrent reinvasions. In San Luis, Ecuador, artisanal miners were promised a formal mining concession outside the boundaries of Podocarpus National Park in return for their voluntary exit, but the concession was never provided and efforts to support livelihood diversification were unsuccessful, resulting in artisanal miners returning to the park. Elsewhere, alternative mining areas have been delineated without adequate knowledge of the mineral reserves. Where allocated areas are unproductive for miners, unsurprisingly reinvasion is common (Figure 26).
- **Understanding local drivers of deforestation and forest degradation helps identify offset options:** In Liberia, understanding pressures arising from the reliance of rural communities on forests for bushmeat, charcoal, firewood, medicinal plants, and subsistence agriculture has enabled identification of offset opportunities close to the mine.
- **Reconciling the needs of communities and forest conservation is essential but challenging**. In the Moyen Bafing National Park offset in Guinea, this involves reconciling the reliance on the forest by people and chimpanzees. The management plan must address both with provisional zoning of land uses within the park based on demographic, socioeconomic, and biodiversity data.

Figure 25
For Biodiversity Offsets to Succeed, They Must Reconcile the Needs of People and Wildlife

Photo credit: Jeremy Holden/FFI

Figure 26
Reinvasion of Forest Areas by Miners Is Common When Alternatives Fail

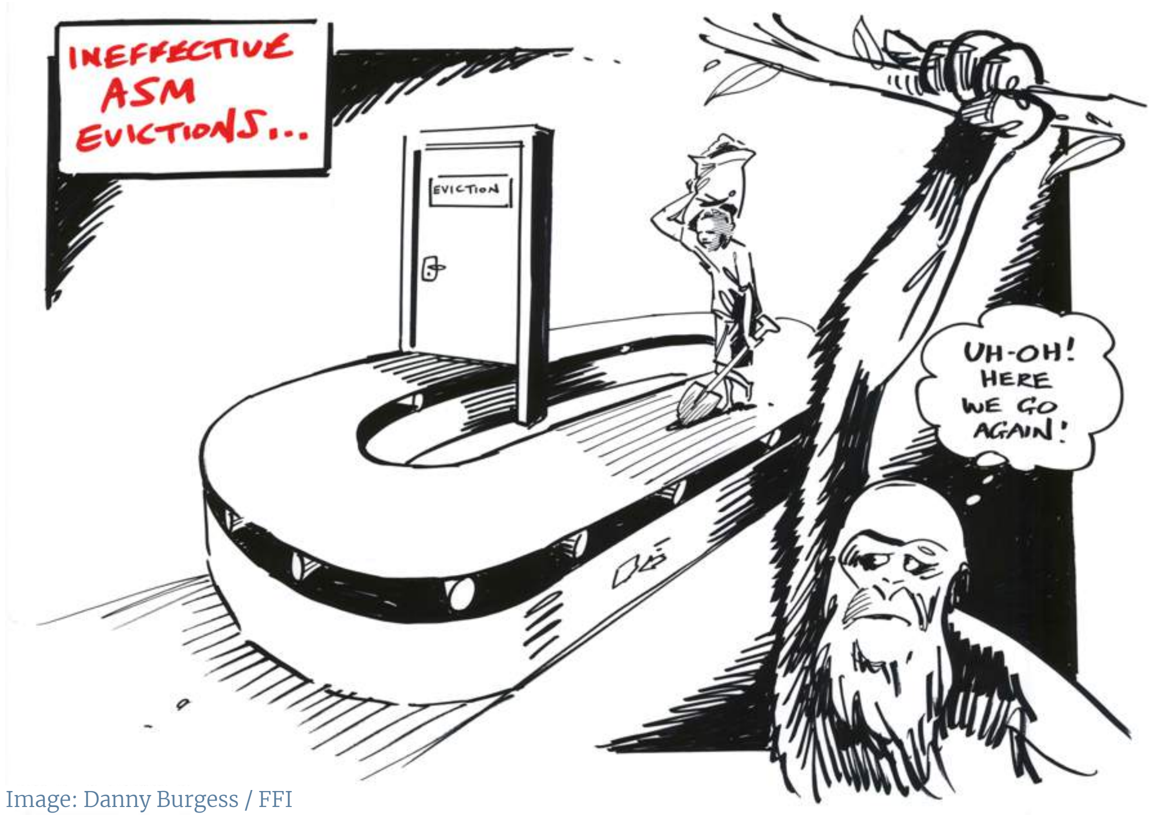

Image: Danny Burgess / FFI

BOX 15

Challenges in Identifying Biodiversity Offsets Options in Complex Forest Landscapes

In complex, multiuse landscapes, identifying and securing suitable like-for-like offsets that have sufficient integrity and are under suitable tenure arrangements is challenging. In Australia, the lack of suitable areas of similar habitat and the fact that many areas have been nutrient-enriched or support invasive species as a result of historic land use has made identifying suitable offset options challenging. In contexts where agricultural land is scarce or in high demand, offsetting can be especially challenging, and where this type of land is taken out of the farming system (for example, to enable a forest restoration offset), compensation and development of alternative sustainable livelihoods for those affected are essential. In Guinea, the Moyen Bafing offset is 200 kilometers away from the mining projects owing to the presence of other valuable mining concessions and the lack of sites with appropriate attributes—in this case, a sufficiently large population of chimpanzees. For Moyen Bafing to succeed, it will be important to manage other development projects in the vicinityso they don't undermine the viability of the park.

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LANDSCAPE CONTEXT

Mining is occurring in complex forest landscapes with an array of different land uses (agriculture, forests, mining, conservation, and so on) and the involvement of multiple government ministries. **Understanding the wider landscape context is essential for determining the impacts of mining on forests and identifying opportunities and constraints for mitigation** (Figure 27).

Landscape-level assessments and strategic ESIAs that consider ecological and sociocultural values alongside development scenarios can help improve understanding of the direct, indirect, and cumulative impacts of different sector developments on forests, inform application of the mitigation hierarchy, including identification of potential biodiversity offset options (Box 15), and identify priority issues that require cross-sectoral engagement and collective action at a landscape scale. Yet in practice, there are few examples of landscape-level, integrated approaches, strategic ESIAs or even coordination of individual ESIAs on the ground, to identify, manage, or monitor mining impacts on forests. One of the few exceptions is Australia, where there is some evidence of coordination of multiple site-level ESIAs.

Figure 27
Landscape Context Can Strongly Influence the Feasibility and Success of Biodiversity Offsets

Image: Danny Burgess / FFI

Photo credit: Roel Slootweg

COMMERCIAL PARAMETERS

Decisions around how and where people mine are influenced by access to finance and mineral resources. Access to capital and conditionalities associated with the source of financing influence the pace at which an area can be mined, the ability to mine responsibly (and to do so consistently), and the standards to which the mine must comply.

For artisanal mining, access to finance is a major barrier to improving environmental practices. Foreign investment can drive surges in mining activity and, in the absence of appropriate safeguards and robust environmental governance, increase forest impacts (Figure 28). Where foreign investment in ASM activities operates outside the formal economy and regulatory environment, activities can be particularly difficult to monitor and control. The case studies point to the pace at which small-scale mechanized mining can take off, with foreign finance-backed, mechanized small-scale mining causing massive disturbance of land. Elsewhere, criminal networks are driving financial flows into the ASM sector in some contexts, with severe implications for forest integrity and health.

The **influence of financing on the mitigation and management of environmental and social impacts of LSM is clearly demonstrated in multi-operator landscapes** where operators are subject to varying standards of performance, as in the bauxite landscape of northwest Guinea. Fluctuations in commodity value (for example, iron ore in Liberia) and market mechanisms (for example, carbon in Kenya) further impact investments in forest conservation and biodiversity offsets: when profits are down, environmental budgets are often the first to be cut and forest conservation efforts are having to cope with unpredictable financial inputs. But sustainable financing is critical for long-term success. Securing adequate finance from project proponents to support offsets is a major risk to implementation. Committed regular operational funding and an endowment are the two main options, with companies often paying into offsets on an annual basis.

Figure 28
Improved Access to Finance Leads to Increased Mechanization of ASM

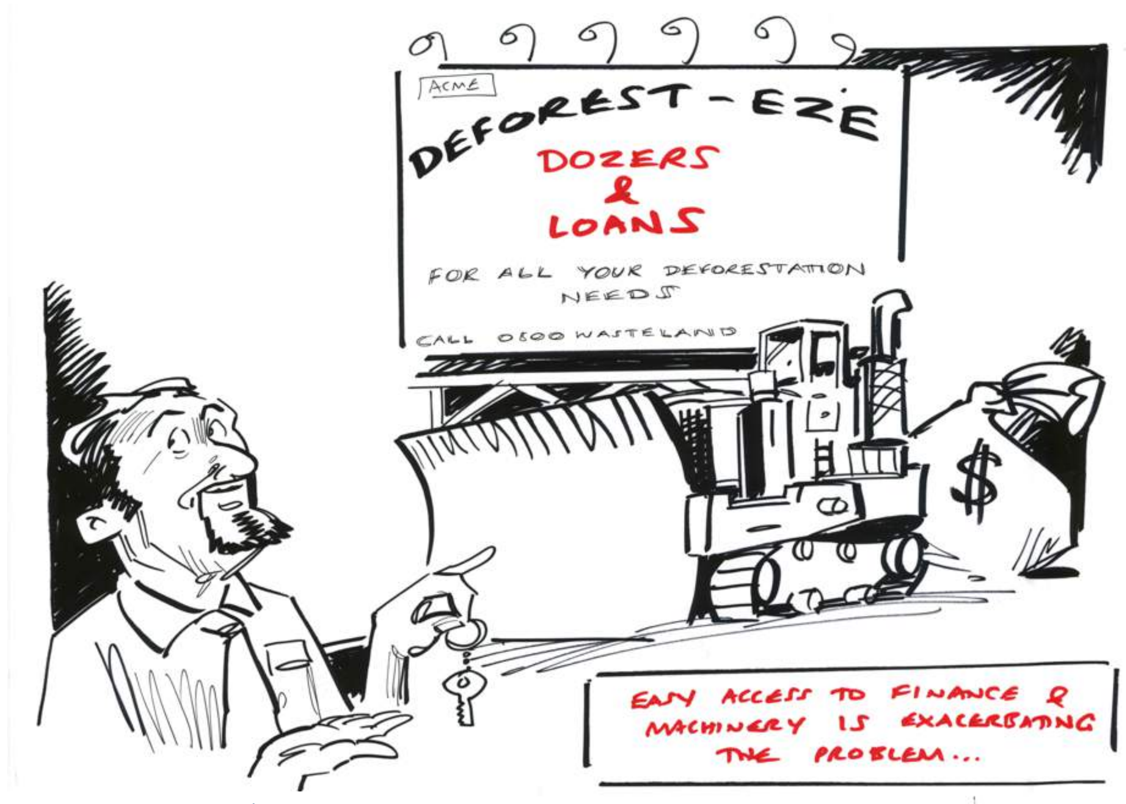

Image: Danny Burgess / FFI

Photo credit: Salajean

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What Is Being Done to Address Forest Impacts?

Photo credit: DDP

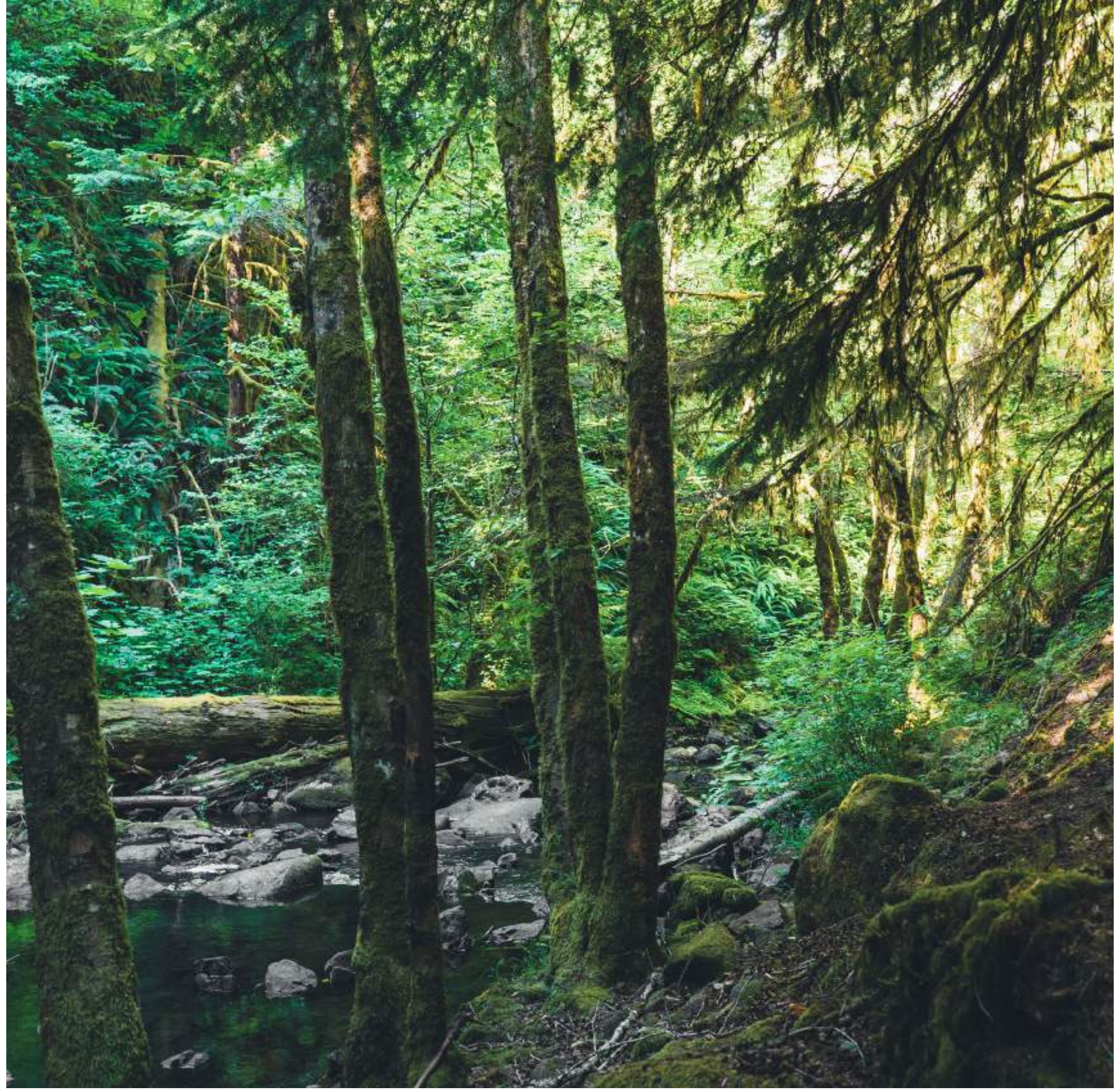

Photo credit: Cristofer Jeschke

IDENTIFYING GOOD AND BAD MINING PRACTICES AND POLICY RESPONSES

Collectively, the case studies showcase the good and the bad in policy and practice across all scales and forms of mining, providing crucial learning to support the development of forest-smart approaches. **No single site, operation, company, or country is considered wholly forest-smart.** The case studies point to a range of practices and policy responses that are not supportive of forest-smart outcomes or where opportunities for forest-smart action have been missed, resisted, or undermined (see Boxes 11 to 14). They highlight a range of challenges and barriers for the adoption of more forest-smart approaches. Notable gaps in mining practice were also identified (Box 16).

However, case studies also demonstrate that forest-smart practices and enabling policy responses are being applied across the mining continuum and in a range of contexts, providing important insight into what forest-smart might look like in practice.

BOX 16

Gaps in Current Practice That Need to Be Addressed to Promote Forest-Smart Outcomes

Informal ASM is poorly positioned to mitigate its impacts, often lacking the necessary capacity, resourcing, and incentives. LSM operators, on the other hand, typically only focus on the mitigation of their direct impacts: these are often more clearly identifiable and attributable to the company and the operation may have greater control over mitigation actions (for example, to minimize noise disturbance or rehabilitate mined areas).

Barriers to the formalization of ASM, as an important step to improving practice, are a concern in nearly all countries studied. Barriers include inadequate legislation, unclear institutional responsibilities, low ability of miners to claim their rights, tenure insecurity, licensing costs, and complexity of the formalization process and regulations governing the sector, among others.*

Few LSM operators are implementing measures to mitigate indirect and induced impacts. Interviews at one LSM operation indicated that staff did not perceive a responsibility for impacts outside the mine footprint and interviews with regulators confirmed there was no expectation for the company to address wider impacts. Thus, while indirect impacts of mining on forests are important at both the local and global scales, responsibilities for mitigation are unclear. In almost all cases, multiple actors share responsibility.

Cumulative impacts are generally considered the responsibility of government and all too often nobody is taking responsibility for identifying and addressing cumulative impacts. Even where impacts are identified by operators, there is often no mechanism by which companies can come together to address them.

Mining operations of all scales are **not taking account of the value of forests early enough** to enable the robust application of the mitigation hierarchy.

Avoidance opportunities are overlooked or fail to materialize, resulting in avoidable forest loss and degradation by LSM operations is some cases. For example, the loss of 100 hectares of old-growth forest at Mertainen in Sweden appears unnecessary given the mine never entered operation. In Liberia, ArcelorMittal's Tokadeh mine was designed to avoid sensitive areas, but inadequate monitoring of activity on the ground resulted in unintended impacts.

Overreliance on restoration and compensation by LSM operators presents risks to forest-smart outcomes: Even where time, resources and capacity are available, there are limitations to restoration owing to long time frames and uncertainties. Compensating for forest degradation and loss is also complex, time-consuming, and costly—and in some cases not possible. Where impacts to forest biodiversity, ecosystem services, or cultural values cannot be restored or compensated for, avoidance is essential to prevent irreplaceable losses.

Monitoring of conservation outcomes from restoration and biodiversity offsets is essential yet often lacking. The case studies highlight challenges in identifying appropriate indicators, long time frames, and the high costs of monitoring programs.

Forest-smart mining is compromised through divestment: The sale of Batu Hijau mine in Indonesia raises questions for the transfer of liabilities. Initial signs are worrying, with the new owners extending the expected mine life by processing stockpiles that were previously considered too polluting to process. With most mines changing hands at some point in their life cycle, this is a key challenge for achieving durable outcomes from forest-smart mining.

* For more information with regards to formalization, barriers, and recommendations, please refer to "PROMINES: Development of Guidance for Self-Assessment by Governments Against the 'Washington Declaration'" and "USAID: Comparative Analysis of Legal and Fiscal Regimes for Artisanal Diamond Mining in Central African Republic," both produced by Levin Sources.

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WHAT IS FOREST-SMART MINING?

Developing a forest-smart approach to mining requires strong governance as well as responsible corporate behavior, empowered communities, and engaged civil society stakeholders.

In this section, critical enabling conditions for forest-smart approaches as well as practical examples of forest-smart mining practices and policy responses are highlighted. This is not intended to be an exhaustive list of all that constitutes forest-smart mining and not all of the enabling conditions and practices identified will be present or feasible in every context. Their absence does not preclude forest-smart approaches but may make them more challenging.

CREATING A POSITIVE ENABLING ENVIRONMENT FOR FOREST-SMART MINING THROUGH GOOD GOVERNANCE

Policy and legislation

- Forest-smart mining is enabled by **policy and legislative frameworks that are robust, stable, and consistently applied** to manage the mining sector and mitigate its impacts, protect forests, and safeguard the rights of indigenous peoples and other local communities. In well-governed forest landscapes, the impacts of mining on forests can be relatively minor even when individual companies are not wholly forest-smart. For example, in Sweden, strong management of forests by the state and other forest owners, coupled with the lack of economic pressure on people to move to the mine region, mitigated impacts of LKAB's Mertainen project on the wider landscape.
- Forest-smart mining is having **legislative frameworks that recognize different scales of mining operation** and adapt requirements accordingly. In Mongolia, ASM was incorporated into the revised Minerals Law of 2010, while in Ecuador environmental and fiscal responsibilities become more stringent with increasing scale of mining operation. Where legislation is inclusive of ASM, appropriately tailored, and authorities have the mandate and capacity to support miners, this can help to encourage ASM formalization and improvements in practice. Lovisagruvan in Sweden illustrates how, under the right conditions, small-scale mining can abide by the same modern environmental requirements applied to LSM operations.
- Forest-smart is ensuring that **environmental requirements are affordable, understandable, and beneficial to artisanal and small-scale miners to incentivize compliance.**
- Forest-smart is **building a clear understanding of the roles and responsibilities of miners, regulators, and other land users,** recognizing the respective capacities of each to fulfil their responsibilities.
- Forest-smart is **establishing appropriate policy and regulation in anticipation of countries transitioning to higher income levels,** which typically generate more readily available financial capital and thus upscaling and mechanization of ASM activities.
- Forest-smart is governments **ensuring that mining companies undertake comprehensive ESIAs prior to mining activity,** providing mechanisms to support the systematic application of the mitigation hierarchy, and establishing mechanisms for the adoption and transfer of liabilities and responsibilities for mitigation.
- Forest-smart is having **no net loss objectives at the state or national level** (for example, in Australia) and **specific laws that promote the implementation of forest-smart activities** (for example, rehabilitation requirements for ASM in Mongolia). This can help to deter development in forests, encourage forest protection, promote robust remediation commitments, and guide biodiversity offsetting.
- Forest-smart is having **pro-forest policies that recognize mining as a driver for forest degradation and loss and are designed to prevent deforestation and promote forest restoration**. REDD+ has been identified as an important but underused mechanism to mitigate mining impacts and protect forests (Box 17).
- Forest-smart is having requirements for, and establishing mechanisms to support, the **inclusion of local communities and other stakeholders** in development planning and decision-making processes.
- Forest-smart is **establishing a supportive enabling environment for biodiversity offsets to contribute permanently to forest conservation.** Governments need to enable the process by finding mechanisms through which companies can fulfill their offset obligations. This may include implementing ESIA legislation or other relevant policies, legal provisions for long-term forest protection, building institutional willingness and capacity within government, creating certainty of land tenure, and supporting the long-term governance of offsets.
- Forest-smart is the **integration of forest-smart approaches into policy and regulation** governing all relevant sectors (that is, mining, forests, agriculture, water, climate, land use planning, conservation, and so on) and supporting implementation through interministerial coordination.

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BOX 17

Potential of REDD+ to Support Forest-Smart Mining and Provide Complementary Lessons for Biodiversity Offsetting in Forest Landscapes

For countries with a significant mining industry and well-developed REDD+ policy framework, REDD+ offers an important mechanism for promoting forest-smart outcomes from mining (Hirons 2013; Laing 2015). To be effective, coordinated action at the national level is needed (Schure 2015). The design of REDD+ standards for the extractives industry, with a no net loss of forest as the goal, is intended to support this process (Hund, Schure, and van der Goes 2017).

Progress to integrate mining and REDD+ is being made in some contexts. For example, the Democratic Republic of Congo's national REDD+ Strategy Framework includes mitigating the potential impact from future infrastructure for LSM and ASM mines in the Congo Basin. The strategy specifies possible mitigation measures and financial compensation, including clarification of legal status of land rights, imposed reforestation after extraction, and an enforced benefit-sharing mechanism (Hund, Schure, and van der Goes 2017). Elsewhere, programs at the national and project levels recognize the impacts of small- and large-scale mining and associated infrastructure development on deforestation and greenhouse gas emissions (for example, Ghana, Zambia), and some mining-focused actions are being taken. In Zambia, this includes the identified need for a national REDD+ center to improve monitoring and reporting of changes in forest cover and the influence of future mining concessions.

Established REDD+ projects offer important, complementary learning to support the design and implementation of biodiversity offsets in forest landscapes. In Kenya, for example, the Kasigau Corridor REDD+ Project shows a market-based approach to offsetting, into which a smaller mining company could invest instead of establishing its own scheme. It points to shared challenges, such as using community-based development models to gain access to land for conservation purposes, the complex institutional arrangements necessary to ensure genuine long-term safeguarding, and making offset payments competitively compelling when other economic opportunities present themselves.

Tenure and rights

- Forest-smart mining is enabled where **forest tenure and rights are clear, there is awareness of access and use rights among stakeholders, and stakeholders are supported to exercise those rights.** In Sweden clear ownership of forests and access rights helps to maintain incentives for forest conservation and ensure that there is accountability to deal with impacts.
- Forest-smart mining is enabled by **tenure systems that *recognize and respect* both modern legal and indigenous and/or customary rights** (for example, Bolivia, Colombia, Ecuador). To be effective, formal and customary rights need to be integrated into all relevant policy and legislation.
- **Forest-smart outcomes may be promoted by strengthening forest tenure and rights among local community stakeholders.** In Madagascar, local landowners have a strong interest in maintaining soil quality and protective forest cover to prevent soil erosion, and this is backed up by robust customary or formal legal rules.
- **Forest-smart is the strong enforcement of indigenous rights.** In cases where indigenous rights are well recognized, stronger enforcement of indigenous rights was associated with better forest outcomes from ASM and stronger forest protection.

Political will, coordination, and institutional capacity

- Forest-smart mining benefits from **interministerial coordination.** In Guinea, the government set up an interministerial commission that enabled different ministries to discuss and resolve possible conflicts and issues relating to a proposed offset site; in Madagascar, the mining and environment ministries coordinate to ensure mining permits are not issued for protected areas.
- Forest-smart is ensuring **effective coordination between different levels of authority.** At Ankarana in Madagascar, the establishment of coordination platforms between park managers and local authorities helped to develop effective strategies for managing illegal ASM, including the eviction of miners from a protected area.
- Forest-smart mining is driven forward where there is **institutional willingness, capacity, and individuals to champion the forest-smart agenda**. In Guinea, institutional willingness and the support of key figures in government has enabled the development of an offset project in an environment with few enabling factors.

Formalization of ASM

- Forest-smart is encouraging **progressive formalization of ASM,** with improving environmental management being a key aspect, supported by enhanced capacity and responsibility. Formalization enables regulators to make ASM more forest-smart by controlling the location of ASM operations, introducing more responsible and efficient mining methods and rules for environmental management, and providing the ASM with legal status, which provides state agents the mandate to engage. ASM operators may benefit from technical support and capacity building so that they are better positioned to take responsibility and start managing their own impacts, as shown in Colombia, Mongolia, and Ecuador.

- **Forest-smart is taking steps to address barriers to formalization.** Key elements to achieve this include strong legal frameworks; organized miners; accessible, simple, and cost-effective governance; empowered government agents; and a progressive formalization approach. Commercial, political, cultural, and social incentives to operate formally can also help.

- Forest-smart is donor programs investing in ASM **taking a holistic approach to environmental management given the threats posed by mechanization,** and program incentives going beyond mercury reduction or increasing investment in ASM formalization to address wider environmental management issues.

Forest protection

- Forest-smart is having **mechanisms to secure the long-term protection of forests while recognizing the rights of users.** For companies to invest significant financial resources into long-term forest protection (for example, through biodiversity offsets), this needs to be enabled by government (for example, through policy and legislation and willingness to partner with private sector) and companies need to have confidence that these areas will remain legally protected. In Guinea, what started out as a potential offset area became a national park. Elsewhere, the focus may be on improving protected areas governance to ensure that protected areas are seen as off-limits and not soft targets for development.

- Forest-smart is **empowering and supporting community organizations to manage forests and protected areas.** In Madagascar, local community organizations are involved in the co-management of Corridor Ankeniheny Zahamena, protecting the area from illegal ASM and improving agricultural practices to reduce pressure on the forest.

In Liberia, the participation of empowered local community stakeholders in the eviction of illegal miners from Sapo National Park contributed to a successful nonviolent and voluntary eviction.

- Forest-smart is mining companies **investing in the protection of forest ecosystems within and beyond the mine concession.** Ambatovy, Société des Mines de Fer de Guinée, ArcelorMittal, and Vale are among the companies investing in forest protection (for example, supporting establishment of community-managed forest areas, working with authorities to improve management effectiveness of protected areas and securing private lands as biodiversity offsets or voluntary protected areas).

- Where mineral deposits are found in protected forest areas and the pull of ASM is strong, the **establishment of clearly demarcated ASM zones that allow mining under certain conditions** can be forest-smart. This is only if there is a relatively high degree of oversight and local stakeholder involvement to ensure that ASM remains within viable limits and complies with environmental responsibilities (for example, multiuse protected areas in Bolivia and some forest reserves in Ghana).

Integrated land use planning

- Forest-smart **development frameworks are multisectoral, multistakeholder, and multi-impact.** This can help develop common goals for sustainability and forest protection, enable the early identification of potential risks and trade-offs, and promote engagement of various stakeholders for greater efficiency in policy planning and implementation. This is particularly important in landscapes where mining may not be the primary driver of deforestation and forest degradation.

- Forest-smart **is integrated land use planning** that involves all relevant stakeholders and sectors (not just mining and forests) and guides the development of mining and other land uses while mitigating forest impacts. In Zambia, the Climate Strategy and Forest Protection Plan took an integrated approach and recommended land use planning to protect key watersheds in North-Western Province.

- Forest-smart mining is the **transparent allocation of concessions** that respects indigenous and other customary rights. In 2016, Liberia released a National Concession Portal that demarcates active commercial concessions and forested areas on a map and aims to improve transparency and allocation of future concessions.

- Forest-smart mining is enabled through the **identification of sensitive areas** that are prioritized for avoidance, protection, or sustainable management: in Mongolia, critical areas for biodiversity were identified through a multistakeholder process to support the strategic planning of infrastructure to avoid impacts.

- Forest-smart mining is the **legal allocation of ASM zones that avoid sensitive forest areas,** respect the rights of indigenous peoples and other local communities, contain viable and accessible mineral deposits, and do not overlap with other mineral concessions (or where they do, access rights are negotiated and managed through formal agreements with appropriate oversight as has been the case in parts of Mongolia). To be effective, ASM zones need to be monitored and enforced. At Loky Manambato in Madagascar, identification of strict conservation areas along with the designation of areas for mining that are recognized by the communities as having high mining potential has helped to relieve pressure on forests important for biodiversity and ecosystem integrity.

CORPORATE POLICIES AND OPERATING STANDARDS

- Forest-smart is **acknowledging and owning the fact that as a mining company you are an agent of development—**good and bad—**stepping into spaces for sharing and empowering and establishing partnerships to achieve forest-smart outcomes.** Companies need to recognize when it is necessary to go beyond compliance. Where governance is weak, forest-smart mining approaches need to be adopted by mining companies in the absence of regulation as "the right thing to do." The major extractive companies and their financial backers will likely play a key role in such scenarios, engaging governments to help achieve forest-smart outcomes.

- Forest-smart mining requires **strong corporate commitments** that are adhered to, embedded in management systems, and consistently applied to drive forest-smart outcomes on the ground. Newmont's commitment to no net loss and Anglo American's commitment to landscape-level coordination are industry-leading commitments with evidence of application on the ground. "No harm" and "no go" commitments in World Heritage sites by companies have resulted in more thorough assessment and consideration of ecosystem impacts in mine planning and design.

- Forest-smart mining is a subset of a wider approach to **responsible mining,** which involves the management of diverse risks, including health, safety, stakeholder welfare, climate, and the environment. Any complacency on one aspect can lead to major impacts in all other aspects. The case studies demonstrate that responsible mining is possible regardless of scale: La Cascada—a formalized ASM cooperative holding a 220-hectare concession in highly biodiverse forest in Colombia—demonstrated best practice that was recognized by Fairmined-certification in 2017. In India, Rio Tinto's Bunder project won the CII-ITC Sustainability Award in 2015 for excellence in embedding social and environmental aspects in business processes.

- Forest-smart is a company **integrating forest protection and forest restoration as core components within its climate mitigation strategy.**

OPERATIONAL BEST PRACTICE SUPPORTS FOREST-SMART OUTCOMES

- Forest-smart is **directing adequate resources to understand the baseline.** Case studies reveal considerable human, financial, and technical investment by some LSM operators into ecological and/or social studies conducted over a number of years (for example, Guinea Alumina Corporation and Compagnie des Bauxites de Guinée in Guinea; ArcelorMittal in Liberia; Alcoa and Rio Tinto in Australia). By establishing robust baselines, these companies have been better able to identify forest-related impacts and mitigation options and to monitor outcomes.

- Forest-smart mining **requires an understanding of the ecology of the forest landscape and the diverse ways in which people interact with and depend on forest ecosystems** (for example, for food, fuel, water, livelihoods). In practice, this may involve establishing baselines that link social and environmental aspects, the coordination of different functions within a mining company (for example, social, environment, water, climate), or undertaking ecosystem services assessments to understand which forest ecosystem services are important for the mine and for community stakeholders.

- Forest-smart is building **no net loss or net gain** into project objectives. Anglo American's Sakatti project in Finland has committed to go beyond compliance and is investigating whether net gain to biodiversity is achievable in this landscape. Anglo American is one of the first global mining companies to try to establish this commitment during the advanced stage of exploration and, if the mine goes ahead, early-stage avoidance through mine design will be key.

- Forest-smart is considering and acting to address **the direct, indirect, and cumulative impacts and the full range of environmental consequences of these impacts for forests and people.** Companies and governments must recognize that the primary impacts of mining are unlikely to be the highly visible ones. Instead, the **biggest impacts are likely to be diffuse, dispersed** over much wider areas, and largely unattributable to a single driver.

- Forest-smart mining is the systematic **application of the mitigation hierarchy** through the life cycle of the mine to achieve specified, demonstrable objectives—typically no net loss or net gain. In most (but not all) LSM case studies and at a minority of ASM sites (for example, La Cascada, Colombia), there was evidence that the mitigation hierarchy was being applied to some degree, with a focus on addressing direct impacts. The case studies point to factors that are important for enabling application of the mitigation hierarchy, including staff retention; adequate and sustained budget allocations; technical support and capacity building; integrated approaches with communication and coordination across departments; clear understanding of roles and responsibilities for implementation by all departments; and collaboration with other actors in the landscape through partnerships, alliances, and microenterprise.

Evidence of forest-smart application of the mitigation hierarchy includes the following:

- **Prioritization of impact avoidance:** For example, forgoing extraction of a proportion of the mineral deposit to prevent the loss of forest and protect its biodiversity, carbon, and/or ecosystem service values; the sensitive placement of linear infrastructure; development of "avoidance buffers" around sensitive forest to protect ecosystem function; operating underground; using certified wood for ASM infrastructure rather than wood logged from the surrounding forest; and ASM zones designated to avoid sensitive forest.

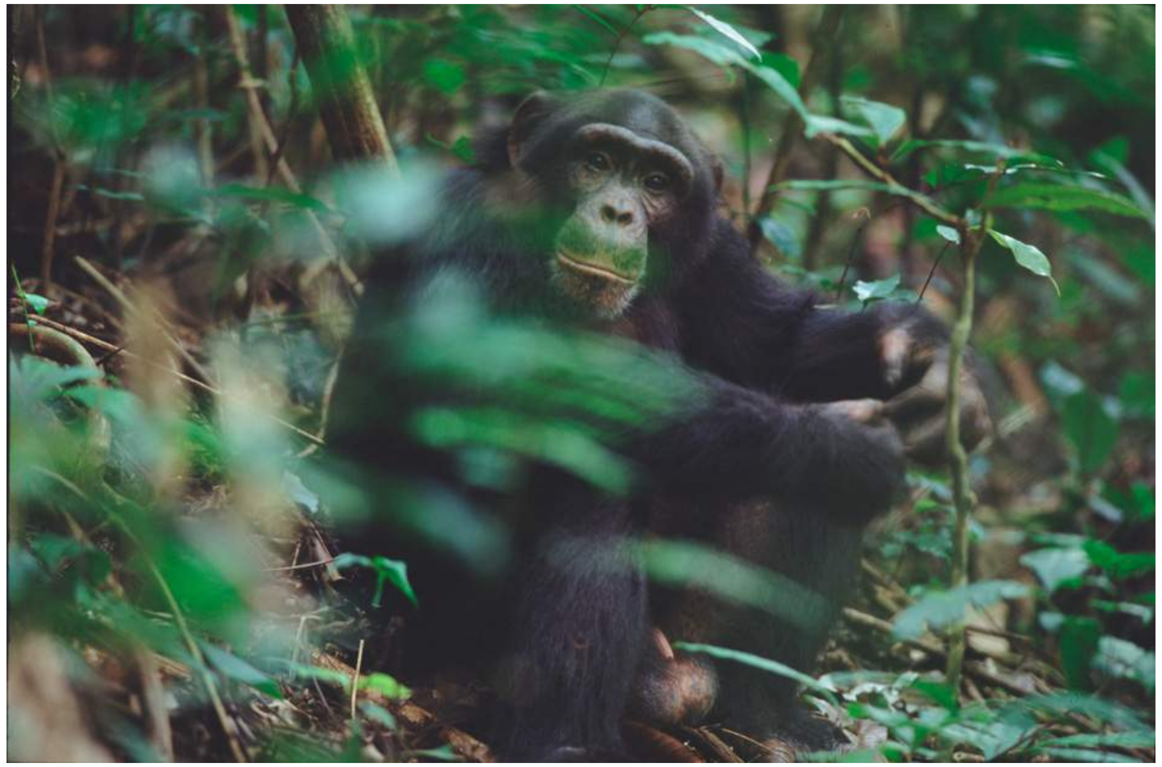
- **Minimization of adverse impacts** on forests: For example, through paced directional clearing and salvage protocols, control and closure of access routes formed during exploration and construction, reducing or removing the use of mercury and phasing out cyanide, and maximizing extraction efficiency to reduce the duration of mining activity.

- **Restoration of impacted and degraded forest** by LSM operators through early application of progressive restoration, using up-to-date techniques and with long-term investment. Collaboration with research institutions and local community involvement are cited as important for success. Some of the best LSM examples are in Australia, where restoration programs aim to restore landscape function and priority ecosystems services on which both company and community depend.

- **Rehabilitation of ASM areas** is uncommon, but there are exceptions. In Mongolia, the Frugal Rehabilitation Methodology has been designed to be economically affordable, socially acceptable, and ecologically viable. Initial results are promising: evidence from pilot sites show progress toward ecological recovery.

- **Biodiversity offsets that maintain large, intact areas of** forest or restore forest ecosystems to maximize biodiversity value, connectivity, and resilience and contribute to the conservation estate of a country (Figure 29).

Figure 29
Aggregated Offsets Have the Potential to Safeguard Large Forest Areas



In Guinea, Compagnie des Bauxites de Guinée and Guinea Alumina Corporation are working together, and in partnership with the government of Guinea, the Wild Chimpanzee Foundation, and International Finance Corporation (IFC), to aggregate their offsets to establish a national park in the Moyen Bafing area of classified forests where approximately 4,400 chimpanzees can be safeguarded. This involves significant investment by the mining companies. Photo credit: Jeremy Holden/FFI

- Forest-smart **is working with local governance to mitigate indirect induced impacts.** Recognizing that demand for water and agricultural land at Bunder in India could lead to illegal logging, the mine worked with village-level elected regulators, the local water department, and an NGO to improve water security and promote more sustainable farming practices, in turn reducing the clearance of forest for agriculture.

- Forest-smart mining is an **integrated approach to the mitigation and management of social and environmental impacts,** supported by regular communication and effective coordination across departments (environment, social, water, climate, legal, mine planning, and so on). In Zambia, this has involved the integration of forest-smart agriculture and conservation livelihoods into social management programs to reduce impacts on forests; in Guinea, the integration of ESIAs and offset feasibility studies is supporting assessment of the environmental *and* social implications of proposed offset measures.

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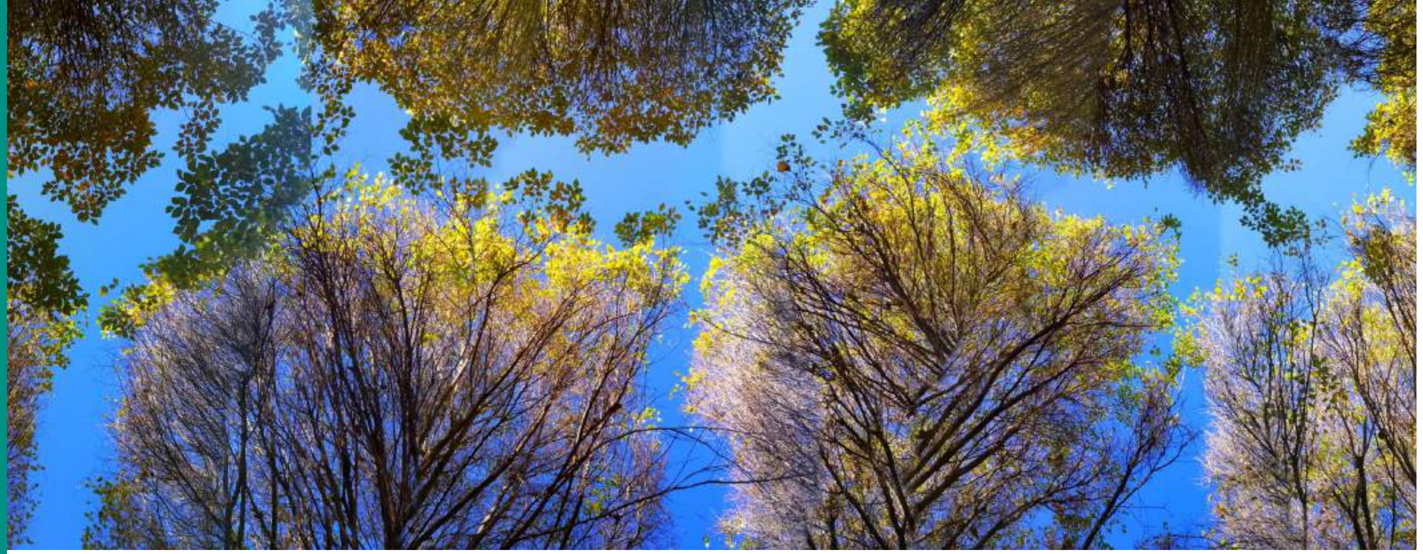

Photo credit: Jack Chen

- Forest-smart mining is about **more than the mitigation of negative impacts.** Grasberg in Indonesia illustrates the potential for driving positive impacts, with a legislative requirement to manage forest in the concession, a demonstrated willingness to invest in biodiversity, and surrounding forest that retains good health.
- Forest-smart is identifying **pragmatic, defensible, and replicable metrics** to monitor impacts and the outcomes of mitigation. A suite of indicators will often be needed and should take into account the scale of mining operation and respective resources and capacity. Metrics are being used to demonstrate compliance with environmental requirements, monitor the outcomes of rehabilitation and restoration, communicate socioeconomic benefits of REDD+, and monitor and mitigate adverse social impacts of biodiversity offsets.
- **Forest-smart is being proactive to achieve positive forest outcomes**. In Liberia, early action by ArcelorMittal to protect the East Nimba Nature Reserve has contributed positively to conservation in the landscape.
- **Efficient mines can be forest-smart mines.** The use of modern technology to extract deposits with efficiency, precision, and limited personnel has contributed to forest-smart mining in Sweden. More efficient extraction of deposits in ASM, coupled with environmental and social safeguards, can reduce repeat mining over extended periods, thereby allowing for rehabilitation.
- Forest-smart is **companies committing adequate financing to secure long-lasting conservation outcomes** from restoration and biodiversity offsets.
- **Forest-smart mining is establishing robust closure plans.** Freeport-McMoRan's experience at its Grasberg mine in Indonesia points to the importance of allowing sufficient time to plan for closure, with funds accrued over the life of mine to enable the delivery of ambitious commitments to restore the site to its original state after 70 years.

GOVERNMENTS, COMPANIES, AND OTHER STAKEHOLDERS IN THE LANDSCAPE WORK TOGETHER TO ANTICIPATE AND MITIGATE MINING IMPACTS AND DRIVE POSITIVE FOREST OUTCOMES

- Forest-smart mining involves **understanding the diverse ways in which different stakeholders benefit from and value forests and raising awareness of the importance of forest** conservation and the fragility of biodiversity and ecosystems services. Ecosystem service assessments, inclusive stakeholder engagement processes, and environmental education programs that elucidate and communicate the impacts and dependencies of mining and communities on forests can help to build support for forest protection and forest restoration measures. The case studies show that when local stakeholders recognize forest values and the need for their conservation, they may be more receptive to proposed measures to safeguard them (for example, in Liberia hunters have observed animal numbers shrinking in all but core forests and so were open to forest conservation proposals).
- **Forest-smart mining requires cross-sectoral collaboration and landscape approaches.** Through the Trident Foundation, First Quantum Minerals has developed innovative partnerships with the Forestry Department and the Department of National Parks and Wildlife in Zambia to manage a large forest landscape, including the West Lunga National Park, together with local communities.
- **Forest-smart is establishing partnerships to achieve long-lasting conservation outcomes.** Partnerships are essential for biodiversity offsets to succeed and endure because the requisite authority and skills are rarely present within a single organization. Partnerships are intrinsically complex and require active management if the collaborative advantage they promise to deliver is to be achieved. Given that all offsets depend on partnerships, their effective governance and oversight is extremely important. **The skill lies in ensuring participatory oversight while limiting bureaucracy.** In Liberia, ArcelorMittal has worked in close partnership with local communities, authorities, and NGOs to implement a long-term biodiversity conservation program.
- Forest-smart mining is **including and supporting community stakeholders as partners** in planning, decision making, and implementation to achieve positive outcomes for forests and communities. At Newmont's Akyem mine in Ghana, involving local communities in the planning and implementation of forest rehabilitation plans led to more secure plots, with local communities receiving long-term stakes in the work and protecting plots from external threats.
- Forest-smart mining involves **building the capacity of partners**. In Kenya, the Kasigau

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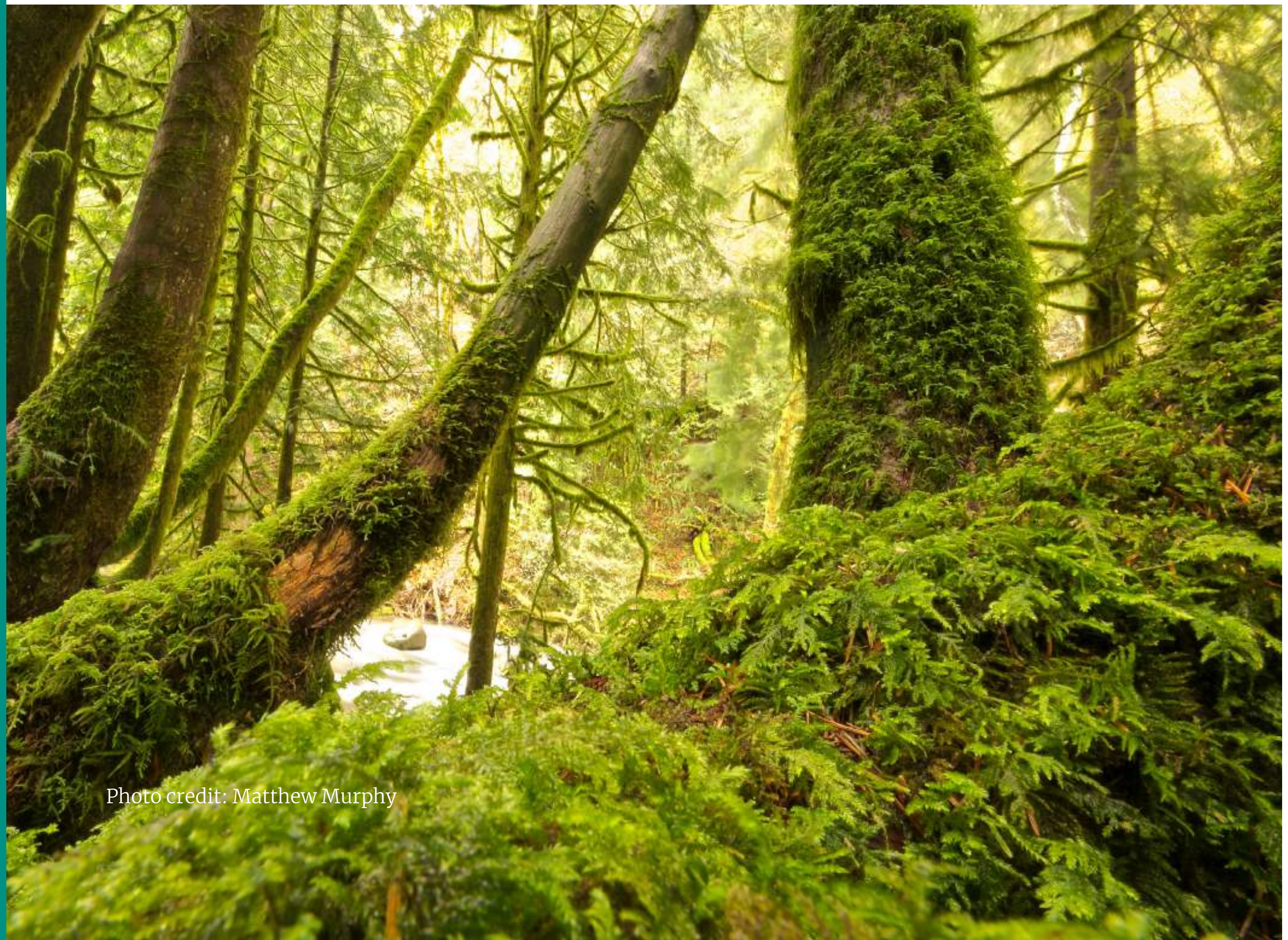
Corridor REDD+ Project worked with communities to build capacity and governance systems and oversaw the establishment of six Locational Carbon Committees to administer the accruing benefits from the project on behalf of the communities.

- **Forest-smart mining becomes a reality when companies and responsible authorities act in tandem.** Corporate transparency at Bunder in India coupled with a diligent regulator enabled recognition of important biodiversity and ecosystem service values while development stage baseline studies were ongoing, in turn improving mitigation.
- Forest-smart mining is **mining operators working together** to mitigate and manage induced and cumulative impacts. At Boké in Guinea, Compagnie des Bauxites de Guinée and Guinea Alumina Corporation have established a platform that aims to bring together different mine operators to address cumulative impacts in the region.
- In landscapes where ASM and LSM coexist, forest-smart mining is an **LSM company identifying opportunities for positive synergies and cooperation with ASM while taking greater responsibility for forest outcomes** in and around its concession. At Fruta del Norte in Ecuador, Lundin Gold's strategy for addressing ASM activity is to work with miners to achieve coexistence, promote formalization, and support those miners willing to comply with the law and the company's recommendations.



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EXTERNAL DRIVERS OF FOREST-SMART MINING

- **External actors promote a supportive enabling environment** for forest-smart mining. Examples range from international donor investment in pro-forest policies (Liberia), research institutions advancing post-mining forest rehabilitation and restoration science (Australia), government, donor and NGO support for the rehabilitation of forest areas impacted by ASM (Mongolia), and (international) financial institutions catalyzing and supporting integrated landscape planning through strategic ESIAs and cumulative impact assessments (Guinea).
- **Forest-smart mining is more likely when shareholders, investors, insurers, and customers require it.** Stipulating forest protection as a priority for liability management can help compel mining companies to build forest-smart mining practices into their policies and procedures and to report on performance. The robust application of environmental and social safeguards by international and regional financial institutions in forest landscapes and the requirements of industry standards and certification schemes such as Fairmined have been shown to help drive forest-smart practices (for example, in Boké, Guinea, investment from IFC and other lenders and robust application of their respective environmental and social safeguards are driving improvements in practice at both new and existing LSM projects).
- **Forest-smart approaches benefit from a strong civil society sector to hold mining operators to account for their forest impacts.** The presence of a strong NGO network in Finland means Anglo American is under intense scrutiny for the development of the Sakatti site and various forums have been established to allow stakeholders an input to the process. This has been a significant factor in ensuring Anglo American has gone beyond compliance from the very start of the mining life cycle.

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Conclusion

Based on the good and bad practices and lessons learned identified through the three studies, a set of principles have been formulated to support the development of context-specific forest-smart mining approaches (Box 18).

Photo credit: Avigator Fortuner

BOX 18

Forest-Smart Mining Principles

	Creating a supportive enabling environment for forest-smart approaches
1	Promote and facilitate secure tenure over forests and forest resources that safeguards and respects indigenous and other customary rights, to support long-term forest stewardship and sustainable use.
2	Policy and regulatory environment stay ahead of the development of the mining sector, are inclusive of ASM (where relevant), and are consistently applied and enforced.
3	Mitigation policy supports forest conservation objectives and considers a no net loss or net gain goal for forests to drive action and accountability on the ground.
4	Protect forests to limit the impacts of mining in forest landscapes and promote investment in forest conservation and restoration, including through biodiversity offsets where appropriate.
5	All actors acknowledge their respective roles and responsibilities in delivering forest-smart mining, recognizing that these will vary in different contexts.
6	Investment in pro-forest policies and long-term financing for forest conservation and restoration are needed.
	Landscape planning and collaboration
7	Integrated landscape planning is paramount, involving all relevant sectors and stakeholders in a forest-smart approach to development.
8	Collaborations, partnerships, and alliances are needed to anticipate, mitigate, and manage forest impacts from mining and promote long-term forest stewardship.
9	Community stakeholders have a critical role to play in promoting forest-smart outcomes and must be empowered and supported to do so.
	Mitigating impacts and driving positive forest outcomes
10	An understanding of forest ecology, the complex relationships between people and forests, and the full range of forest values must underpin forest-smart approaches to mining.
11	Being forest-smart means anticipating and mitigating all impacts on forests, prioritizing avoidance, and being proactive in driving positive forest outcomes.
12	Local socio-political, economic, and ecological conditions inform the design and implementation of context-appropriate mitigation action.
13	Monitor conservation outcomes, using indicators that are pragmatic, defensible, and replicable, to support adaptive management and demonstrate forest conservation outcomes.
	Forest-smart is climate-smart
14	Forest-smart approaches to mining that protect forests and promote forest restoration are a crucial tool for combating climate change.

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All actors have a critical role to play in promoting and enabling forest-smart approaches to mining and there is an urgent need for action:

- Governments to **develop a supportive policy and regulatory environment for forest-smart mining *and* ensure the necessary capacity, resourcing, and coordination to enable consistent application and enforcement** (for example, through development or strengthening of relevant policies and legislation, greater investment in environmental protection agencies or finding mechanisms to improve coordination among ministries), supported by donors and other stakeholders.

- Governments to **secure the long-term protection of forests** (for example, through designation of remaining intact forests as protected areas, establishing mechanisms to support community-based sustainable forest management, improved protected areas governance). Companies, investors, donors, NGOs, and communities to support this process through expertise, management support, and financing.

- Companies and investors to **recognize when it is necessary to go beyond compliance.** For example, where customary rights are not legally recognized, companies need to integrate these independently. In contexts where governance and planning processes are suboptimal in terms of conservation, companies will need to put considerable emphasis on engaging governments to help drive positive forest outcomes (for example, to find offset sites where long-term protection can be secured).

- Governments, companies, and investors to **catalyze, facilitate, and support landscape planning processes** that are multisectoral, multi-impact, and multistakeholder. In Guinea, the World Bank is funding a regional planning strategy and cumulative impact assessment for the Boké landscape. Elsewhere, mining companies are playing an active role in regional development planning. For example, Anglo American is working to bring long-term, collaborative regional development opportunities to operating regions using spatial planning to help identify socioeconomic development opportunities with the greatest potential and catalyzing partnerships with a broad range of stakeholders to support implementation.

- Governments, companies, investors, and civil society groups need to **find opportunities and mechanisms to support greater collaboration** among sectors and stakeholders to achieve forest-smart outcomes. This may be enabled by the Chamber of Mines, for example, or through company- and/or investor-led collaborative platforms or donor-backed civil society initiatives.

- To achieve positive outcomes for forests, governments and companies need to **engage and support communities as partners in planning, decision making, and implementation.** Community support for forest-smart approaches will be conditional on ensuring that rights are respected, and that subsistence and livelihood needs are not adversely impacted or are adequately compensated for. **Finding livelihood options that are viable and sustainable alternatives** to ASM or where restrictions are imposed on communities within an offset area continues to prove challenging and should be prioritized for attention and investment.

- Companies to **ensure there is adequate financing to achieve conservation outcomes** from restoration and biodiversity offsets that are long-lasting. Financial and other institutions to expend more effort to establish a broader range of financing options.

- Investors to **communicate the protection of forests as a priority** to mining companies and those that buy from them, to incentivize the incorporation of policies, procedures, and operating and reporting practices that support forest-smart outcomes. Standard setters to compel or incentivize members to introduce forest-smart mining management systems.

- Governments and companies, supported by donors and investors, need to **better understand and mainstream the full value of forests at different spatial and temporal scales into development planning** and to do so early enough to allow for the robust application of the mitigation hierarchy. At the national level, the *Wealth Accounting and the Valuation of Ecosystem Services (WAVES) Global Partnership Program* is supporting this process in nine countries. At the site level, some operations are undertaking ecosystem service assessments, improving coordination between social and environmental teams, and collaborating with NGOs, communities, and research institutions to better understand forest ecology and importance of forests to local and national stakeholders.

- The mining sector to **address mining-led deforestation and forest degradation and be proactive in promoting forest protection and restoration** in operating landscapes as a critical strategy to mitigate climate change. The alignment of forest-smart approaches with existing frameworks for forest protection and restoration, particularly REDD+, may help to maximize synergies, resources, and support.

The three full "Forest-Smart Mining" reports, which look into large-scale mining, artisanal and small-scale mining and biodiversity offsets and include detailed case studies and stakeholder specific recommendations, can be downloaded at: *www.profor.info*

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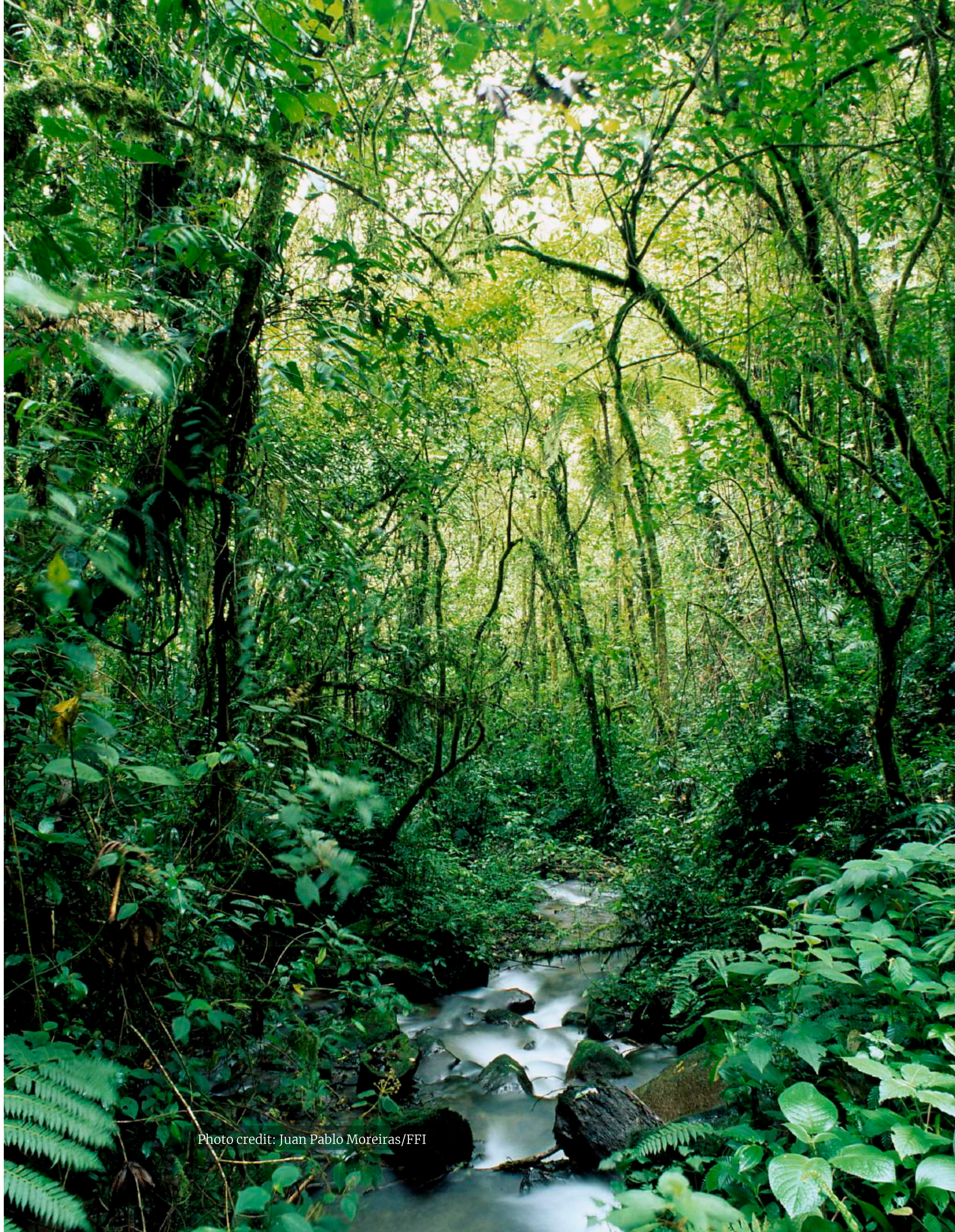

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