Research Paper

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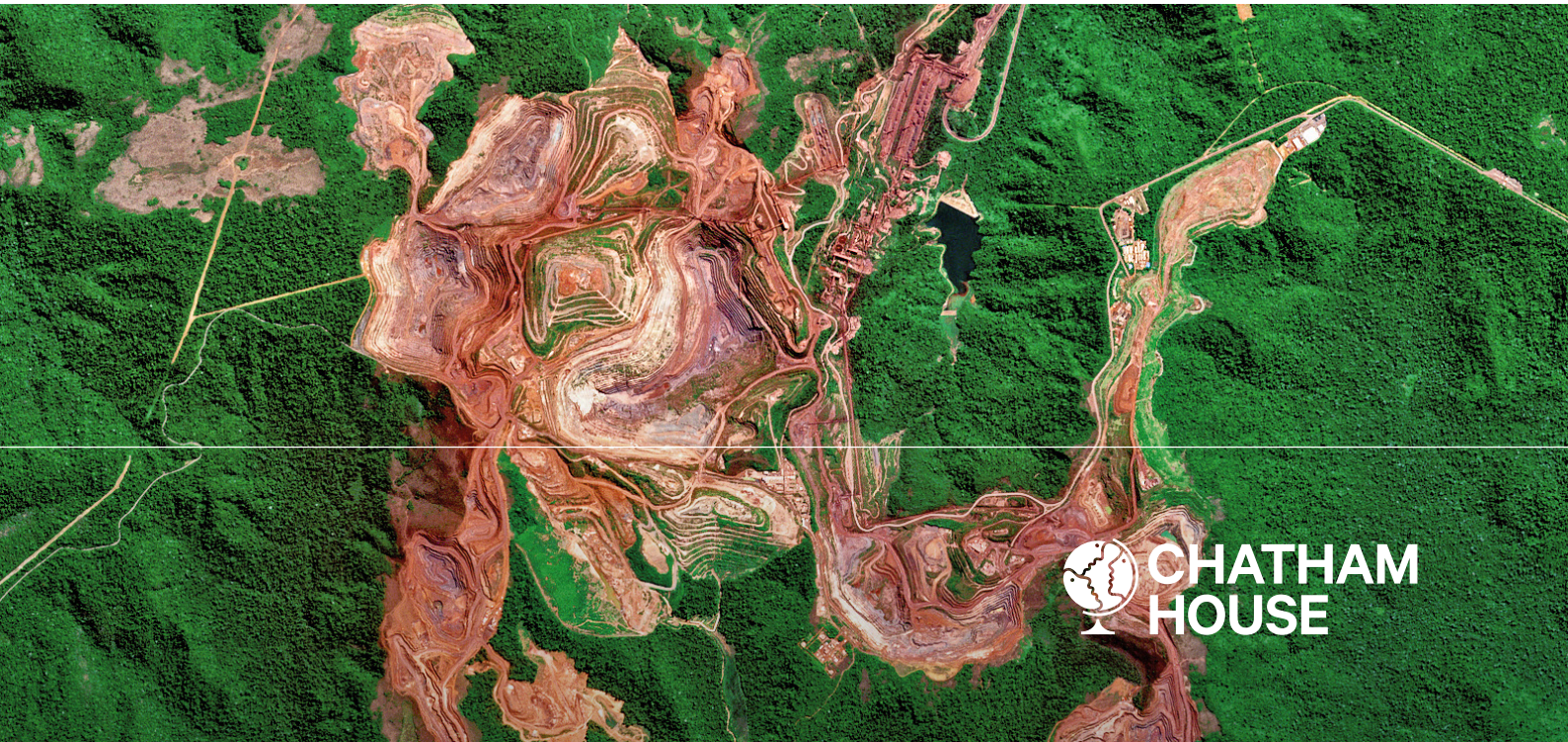
Mining's Impacts on Forests

Aligning Policy and Finance for Climate and Biodiversity Goals



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Summary

- Delivering the long-term aims of the Paris Agreement will require a rapid halt to deforestation, and reforestation and afforestation at scale. It will also require a secure and sustainable supply of minerals and materials for green technologies and sustainable infrastructure. While mining is not always a primary direct driver of deforestation and forest degradation, its indirect and cumulative forest impacts can be significant. Up to one-third of the world's forests may already be affected by mining, with regions such as the Amazon, the Congo Basin and Southeast Asia at particular risk. Given the anticipated demand for minerals such as iron ore, copper, gold, nickel, cobalt and bauxite – which are often found in critical forest landscapes – it is important that the mining sector's forest impacts are better understood and addressed.
- There is growing scrutiny of the mining sector's climate impacts, but the links between forest impacts at project level and climate commitments at corporate level remain underexplored. The monitoring and reporting of mining's direct and indirect roles in land-use change, including forest loss and degradation, could support a more comprehensive assessment of the sector's contribution to climate change and biodiversity loss. This should include greenhouse gas (GHG) emissions associated with deforestation and forest degradation, and the net impact on forest carbon stocks. More transparent, integrated approaches to assessing and reporting the sector's forest impacts – both in terms of climate change and biodiversity – could encourage the development of 'forest-smart' mining policies and practices which avoid deforestation and, where appropriate, support the reforestation or afforestation of mined land.
- With growing pressure for mining companies to commit to net-zero emissions, there is rising interest in forest carbon offsets. Investing in forests is one of the most cost-effective tools in climate mitigation, and the development of forest finance mechanisms that increase private sector investment may help protect forests and reduce emissions, as well as delivering co-benefits for biodiversity and sustainable development. In some cases, it may be appropriate to use forest carbon markets to help address mining's impacts, particularly in producer countries and regions, where offsets can be aligned with forest impacts. However, there remains considerable variation in how companies report the use of offsets, and in the level of detail available on the underlying forest assets. Greater transparency and common standards are crucial if forest carbon offsets are to help provide a bridge to more ambitious climate commitments, rather than a 'get-out clause'.
- Raising the profile of forest-risk mineral commodities could help build consumer demand for low-impact, low-carbon metals. In order for consumers and investors to consider the full costs of mineral production and supply chains in their decision-making, GHG emissions associated with forest loss and degradation should be incorporated into supply chain standards and market mechanisms, alongside impacts on biodiversity, land and water. Further research into 'forest-risk mineral supply chains' and efforts to raise the profile of them may encourage better monitoring and reporting of the mining sector's forest impacts, and support policy engagement with producer countries and companies, incentivizing forest-smart approaches to mining and the development of deforestation-free mineral supply chains.

- Countries with a high dependency on mining and a high vulnerability to forest impacts – such as Brazil, the Democratic Republic of the Congo (DRC), Ecuador, Guinea, Indonesia and Zambia – could benefit from national roadmaps for more sustainable, forest-smart mining. Governance of the mining sector should be strengthened to account for forest risks, and encourage forest protection and restoration, particularly at the licensing and decommissioning stages. The development of the mining sector should also be assessed in light of national sustainable development plans and Nationally Determined Contributions (NDCs) under the Paris Agreement, including reforestation and afforestation commitments. Such assessments could support integrated planning and identify entry points for finance, including REDD+. They should be supported by robust analysis and multi-stakeholder dialogue and should consider, on a case-by-case basis, whether mining in forests can be justified at all.

1. Introduction

Minerals have an important role to play in supporting the transition to a decarbonized, sustainable economy. At the same time, there is an urgent need to halt deforestation and to support reforestation and afforestation at scale – in order to keep the rise in global average temperature well below 2°C and as close as possible to 1.5°C above pre-industrial levels, in line with the Paris Agreement on climate change. Significant shares of production and reserves of some of the minerals required for clean energy technologies and sustainable infrastructure – such as iron ore, copper, nickel, bauxite and cobalt – are found in critical forest landscapes. With rising demand anticipated for many mineral commodities,[1] alongside the depletion of accessible reserves and declining ore grades across the sector, mining is likely to push further into forest landscapes, increasing the risk of deforestation and forest degradation.

While investors and consumers are increasingly aware of the sector's wider climate impacts, the forest impacts associated with mineral supply chains – and their implications for greenhouse gas (GHG) emissions and biodiversity loss – remain something of a blind spot. In order to ensure that the mining sector's contribution to transition is as sustainable as possible, there is an urgent need for stakeholders along the minerals value chain to work together to: mitigate the emissions associated with mining and mineral supply chains; alleviate the impacts of mining on nature, including air, land, forests, water and biodiversity; reduce demand for mineral commodities by improving resource efficiency; and, over time, move away from linear supply chains and towards a circular economy.

This paper explores the impacts of large-scale mining on forests, within this wider context of transition. It expands upon the key themes of a research workshop which was held at Chatham House in May 2019, with the objective of identifying areas for further research and engagement. Section 2 explores the current state of knowledge around mining-induced deforestation and forest degradation, and the potential that 'forest-smart' approaches to mining may offer. Section 3 considers the extent to which mining's forest impacts are acknowledged by consumers and investors, and the potential for emerging forest finance mechanisms and forest monitoring systems to raise awareness around the mining sector's forest impacts, and encourage forest protection and restoration. Section 4 signposts several areas where the mining sector's impacts on forests could be better addressed at country, company and sector level.

[1] See Hund, K., La Porta, D., Fabregas, T., Laing, T. and Drexhage, J. (2020), *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition,* Washington, DC: World Bank Group, http://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf (accessed 28 May 2020).

2. Mining's Impacts on Forests

Better understanding of the drivers of deforestation and forest degradation is crucial to safeguarding forests. It is thought that around 73 per cent of deforestation is driven by commercial agriculture and subsistence agriculture, 10 per cent by urban expansion and infrastructure respectively, and 7 per cent by mining.[2] Research has tended to focus on the major drivers of deforestation, notably the production of agricultural commodities, while the development of data on other drivers of deforestation such as mining and infrastructure has lagged.[3] A Chatham House workshop in 2015 explored the available information on mining's impacts on forests. It found that while the sector's direct impacts were relatively well detailed by case studies, there was far less understanding of its indirect and cumulative impacts, and no comprehensive review of its aggregate impacts.[4] Since then, a body of research exploring mining's wider impacts on forests at regional and global level has emerged.[5] This includes a series of three World Bank reports which explore the impacts of large-scale, artisanal and small-scale mining and the sector's engagement with carbon and biodiversity offsets.[6] This paper builds upon these reports, the aforementioned workshop and stakeholder engagement in the UK and China through 2019 and early 2020.[7]

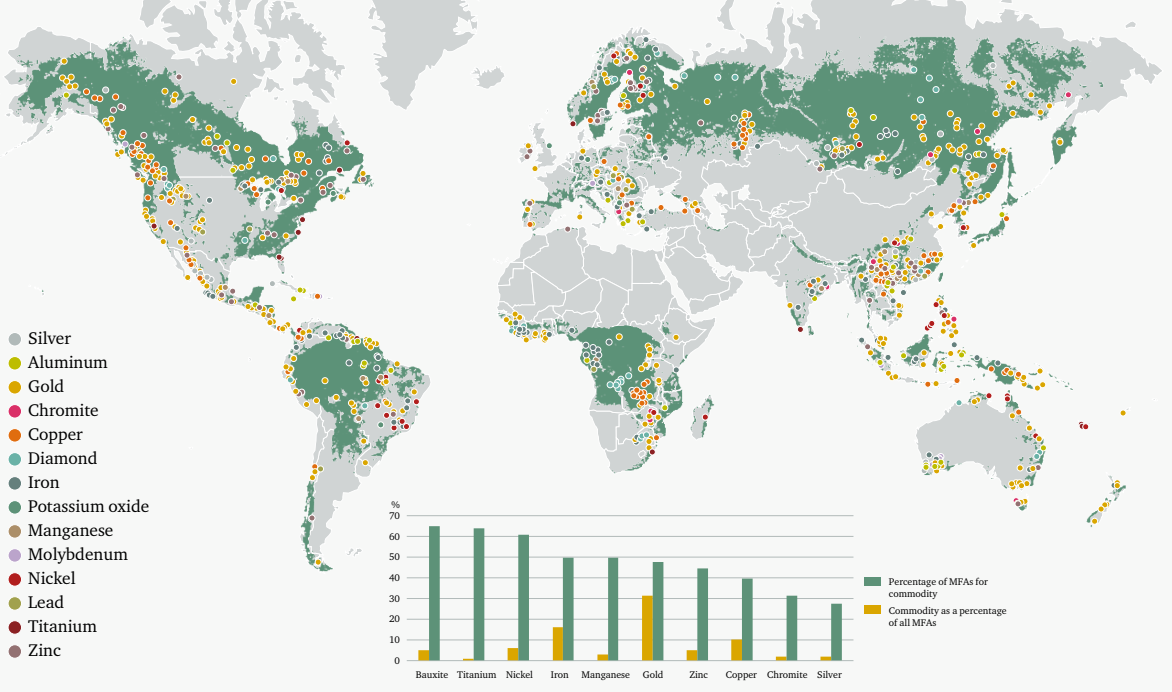
While mining's direct impact on forests is often limited, its indirect and cumulative impacts can be significant. Mining's *direct* impacts on forests include land-use change at mine sites, and downstream pollution and environmental damage. The sector's *indirect* and *cumulative* impacts can be much more significant. They include those associated with the development of road, rail and port infrastructure for the transport and export of minerals, and the impacts associated with inflows of workers and other economic activities such as logging as infrastructure opens forests up. The above-mentioned World Bank studies identified 3,300 large-scale mines in forests, including 1,500 active mines and a further 1,800 lying idle or under development. They found evidence of forest loss and degradation within a radius of 50 km of most of the mines, and in some cases of up to 100 km. The findings suggest that at least 10 per cent and up to one-third of the world's forests may already be affected by mining.

[2] Hosunuma, N., Herold, M., De Sy, V., De Fries, R. S., Brockhaus, M., Verchot, L., Angelsen, A. and Romijn, E. (2012), 'An assessment of deforestation and forest degradation drivers in developing countries', *Environmental Research Letters*, 7(2012) 044009, https://www.cifor.org/publications/pdf_files/articles/ABrockhaus1201.pdf (accessed 12 May 2020).
[3] Pendrill, F., Persson, U. M., Godar, J., Kastner, T., Moran, D., Schmidt, S. and Wood, R. (2019), 'Agricultural and forestry trade drives large share of tropical deforestation emissions', *Global Environmental Change*, 56: pp. 1–10, https://www.sciencedirect.com/science/article/pii/S0959378018314365 (accessed 12 May 2020).
[4] Royal Institute of International Affairs (2015), 'The Impact of Mining on Forests: Information Needs for Effective Policy Responses', Meeting Summary, 3 June 2015, https://www.chathamhouse.org/sites/default/files/events/special/Mining_workshop_summary_final.pdf (accessed 12 May 2020).
[5] See, for example, Bebbington, A. J., Humphreys Bebbington, D. and Sauls, L. A. (2018), *Assessment and Scoping of Extractive Industry and Infrastructure in Relation to Deforestation: Global and Synthesis Report*, Climate and Land Use Alliance, http://www.climateandlandusealliance.org/wp-content/uploads/2018/12/Executive-Summary-Global-Synthesis-Impacts-of-EII-on-Forests-1.pdf (accessed 23 Mar. 2020); and WWF (2018), *Assessing the potential threat of extractive industries to tropical intact forest landscapes*, https://wwf.panda.org/knowledge_hub/?331793/Report-Assessing-the-potential-threat-of-extractive-industries-to-tropical-intact-forest-landscapes (accessed 12 May 2020).
[6] These reports were commissioned by the World Bank and the Program on Forests (PROFOR) and delivered by a consortium including Fauna and Flora International, Levin Sources, Fairfields Consulting and Swedish Geological AB. All three are available at https://www.profor.info/knowledge/extractive-industries-forest-landscapes-balancing-trade-offs-and-maximizing-benefits (accessed 12 May 2020).
[7] The Chatham House research workshop 'The Role of Innovative Technologies and Finance in Advancing Forest-Smart Mining' was held on 10 May 2019. See https://www.chathamhouse.org/event/role-innovative-technologies-and-finance-advancing-forest-smart-mining (accessed 10 May 2020). See acknowledgments section for further details.

Similarly, research on deforestation in the Amazon has detected evidence of forest impacts within a radius of up to 70 km of mine sites, and suggests that mining accounted for almost 10 per cent of all Amazon forest loss between 2005 and 2015.[8]

The forest impacts of mining tend to be concentrated in certain countries, and associated with particular commodity supply chains. Figure 1 shows large-scale operational mines in forest areas, with each mine labelled according to the primary commodity it produces. Almost three-quarters of these mines are in low- and middle-income countries, including Brazil, the Democratic Republic of the Congo (DRC), Ecuador, Ghana, Indonesia, Liberia, Madagascar, the Philippines, Suriname, Zambia and Zimbabwe. The inset figure shows that the top three minerals (by volume) mined in forests are gold (often mined in valuable biome forests), iron ore and copper. The mineral supply chains most reliant on forest mines are those for bauxite, titanium and nickel, with more than 60 per cent of the mines for each of these commodities located in forest landscapes.[9] The type of mining, its infrastructure requirements and its effective 'footprint' will vary between commodities. Low-value, high-volume commodities such as iron ore and bauxite require far more extensive infrastructure than do high-value, low-volume commodities such as gold and cobalt. The companies whose portfolios have the highest proportion of mines in forest areas include Alcoa, ArcelorMittal, RUSAL, Vale, and several Chinese and Russian state-owned enterprises (SOEs).

Figure 1: Large-scale mines in forest areas (MFAs), by primary commodity



Source: Image reproduced and adapted from World Bank (2019), *Making Mining Forest-Smart*, Executive Summary Report, p. 33, https://www.profor.info/sites/profor.info/files/Forest%20Smart%20Mining%20Executive%20Summary-fv_0.pdf (accessed 13 Oct. 2020); mine, commodity and forest cover data drawn from World Bank (2019), *Forest-Smart Mining: Identifying Factors Associated with the Impacts of Large-Scale Mining on Forests*, Washington, DC: World Bank, https://www.profor.info/sites/profor.info/files/Forest%20Smart%20Mining_LSM%20REPORT_0.pdf (accessed 13 Oct. 2020).

[8] Sonter, L. J., Herrera, D., Barrett, D. J., Galford, G. L., Moran, C. J. and Soares-Filho, B. S. (2018), 'Mining drives extensive deforestation in the Brazilian Amazon', *Nature Communications*, 8: 1013, https://www.nature.com/articles/s41467-017-00557-w.epdf?author_access_token=0zkGGfo8nzkVzWR59YoKx9RgN0jAjWel9jnR3ZoTv0PxaSsLyPxdt4mBwruCIzKNSYm-akEL7-BlIhZoszC4NGVL1IpcmV2RkLUYJgNP4lRqWM00zXzXWl-y1dN5khtJb0ABGc8EEUkJENz9j4ETwA%3D%3D (accessed 12 May 2020).

[9] For further details, see World Bank (2019), *Forest-Smart Mining: Identifying Factors Associated with the Impacts of Large-Scale Mining on Forests,* Washington, DC: World Bank, https://www.profor.info/sites/profor.info/files/Forest%20Smart%20Mining_LSM%20REPORT_0.pdf (accessed 12 May 2020).

The potential for 'forest-smart' mining

As a *concept*, forest-smart mining can be understood as mining that acknowledges the interlinkages between forests and other land uses – including socio-economic and cultural uses, and ecosystem services – and that actively seeks to avoid or reduce any loss or damage to those uses. In some cases, it may even promote a net gain for them. The World Bank identifies forest-smart mining as one of the building blocks of climate-smart mining more broadly: its Climate Smart Mining Initiative aims to help developing countries benefit from the growing demand for minerals that will be crucial to the transition to a decarbonized economy, while minimizing the climate and environmental impacts of their extraction.[10] At its most basic, forest-smart mining means following the mitigation hierarchy when planning and developing mining projects, namely:

- First, avoiding any negative climate impacts and biodiversity loss;
- Second, minimizing any impacts and losses that still occur;
- Third, rehabilitating and restoring forest cover and biodiversity where there are unavoidable negative impacts and losses; and
- Fourth, as a last resort, offsetting any remaining negative impacts or losses through substitution or compensation.[11]

As a *practice*, forest-smart mining entails the implementation of a range of approaches and tools that span the mitigation hierarchy. It is typically guided by an overarching policy commitment to no net loss of forest cover, or even by a commitment to net gain where there is potential for reforestation or afforestation. As Figure 2 shows, the forest-smart mining 'toolkit' is broad, and the exact tools available will vary according to the context of the mine and the stage of mining activity. Forest-smart approaches at the higher end of the mitigation hierarchy include undertaking strategic and cumulative impact assessments, identifying 'no go' areas for mining, minimizing polluting waste and avoiding accidents. Options at the lower end of the mitigation hierarchy include land restoration and the development of carbon and biodiversity offsets.

While there is a growing body of best practice, no country, company or mine is 100 per cent forest-smart at present. The World Bank study on the forest impacts of large-scale mining, mentioned above, assessed 21 case studies across 14 countries and found that direct forest impacts are most often and most effectively addressed. By contrast, efforts to address indirect and cumulative impacts through integrated, landscape-level approaches tend to be hampered by a lack of clarity between governments and companies over who is responsible for forest impacts, and for financing and implementing mitigating measures.

Timing also matters, as forest impacts tend to peak around the construction phase. While forest-smart approaches can be deployed at all stages of the project cycle, they are most effective when integrated into the decision on whether to proceed with mining, and into project planning and mine development from the outset. Opportunities to mitigate forest impacts become more limited

[10] World Bank (2019), 'Climate-Smart Mining: Minerals for Climate Action', video, https://www.worldbank.org/en/topic/extractiveindustries/brief/climate-smart-mining-minerals-for-climate-action (accessed 12 May 2020).

[11] The Cross-Sector Biodiversity Initiative (CSBI) defines the mitigation hierarchy as 'the sequence of actions to anticipate and avoid impacts on biodiversity and ecosystem services; and where avoidance is not possible, minimize; and, when impacts occur, rehabilitate or restore; and where significant residual impacts remain, offset'. It should be noted that 1) 'minimize' typically means to reduce to the extent possible rather than to zero; 2) land rehabilitation, reclamation and remediation only amount to 'restoration' where they ensure gains for specific biodiversity and ecosystem services that are targets for mitigation; and 3) 'offsetting' can include substitution or compensation as a last resort, although compensation is not possible for many ecosystem services. See Ekstrom, J., Bennun, L. and Mitchell, R. (2015), *A cross-sector guide for implementing the Mitigation Hierarchy*, Cross-Sector Biodiversity Initiative (CSBI), http://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-Mitigation-Hierarchy-Guide.pdf (accessed 10 May 2020).

once mines are in operation (as well as more technically difficult and expensive to introduce retrospectively). There may still, however, be significant opportunities for progressive rehabilitation and for reforestation and afforestation at the mine closure stage.

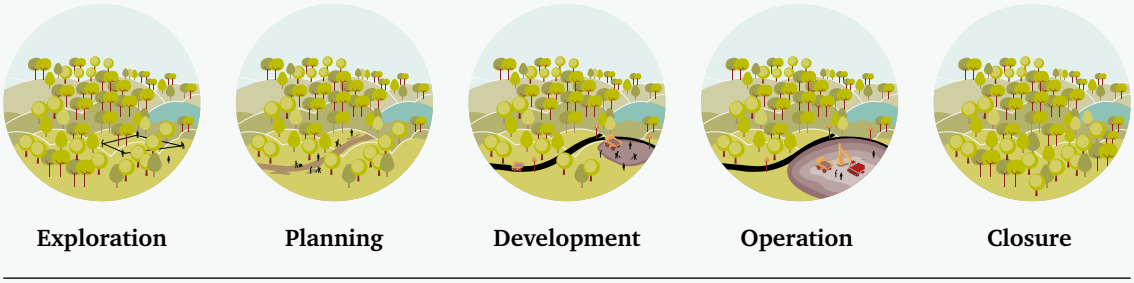
> While forest-smart approaches can be deployed at all stages of the project cycle, they are most effective when integrated into the decision on whether to proceed with mining, and into project planning and mine development from the outset.

There is a strong correlation between best practice and good governance. While large-scale mining is generally guided by well-developed legal, regulatory and policy frameworks, levels of implementation and enforcement will vary by jurisdiction. As Figure 1 shows, over half of all operational mines in forests are in low- or lower-middle-income countries, where institutional, technical and financial capacity is often weaker. With effective stakeholder engagement, integrated landscape-level approaches may help to ensure that interventions are locally appropriate and take into account the socio-economic and environmental needs of local stakeholders, particularly communities and workers. However, such approaches require considerable institutional, technical and financial capacity, and have proven challenging to implement in countries such as Indonesia.[12]

There also appears to be heavy reliance on tools at the lower end of the mitigation hierarchy. Offsets should be a last resort, yet in practice they account for many of the forest-smart approaches cited. To be effective, offsets must demonstrate equivalency, yet this is difficult given the timeframe between the loss of forest carbon and/or biodiversity and the reversal of this loss (or even net gain) as a result of offsetting, and given methodological challenges in quantifying the amount of carbon held by forests now and in the future.[13] Reforestation does not guarantee functional ecosystems or biodiversity; indeed, many ecosystem services cannot be offset, and mature (or 'old') forests – which play a specific role in carbon sequestration and other ecosystem services – cannot simply be replaced. Offsets must also demonstrate permanence to ensure the long-term protection of forests. This is already a challenge in weak regulatory environments, and will become more so as climate change increases pressure and impacts on land.[14] Offsets also require long-term finance, yet there remain serious questions around how finance can be guaranteed when mining projects change ownership or when companies are dissolved. Given the wider socio-economic and cultural role of forests, and the potential for offsets to have negative socio-economic impacts and exacerbate inequalities within and between countries, offsets also raise serious equity questions.[15]

[12] Indonesia's OneMap Initiative was designed to address overlapping land claims but has proved challenging to implement. See World Resources Institute (2019), 'Understanding Indonesia's OneMap Initiative', https://www.wri.org/tags/understanding-indonesias-onemap-initiative (accessed 12 May 2020).
[13] Baccini, A., Walker, W., Carvalho, L., Farina, M., Sulla-Menashe, D. and Houghton, R. A. (2017), 'Tropical forests are a net carbon source based on aboveground measurements of gain and loss', *Science*, 13 Oct 2017: Vol. 358, Issue 6360, pp. 230–34, DOI: 10.1126/science.aam5962.
[14] Intergovernmental Panel on Climate Change (IPCC) (2019), *Climate Change and Land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, https://www.ipcc.ch/srccl/ (accessed 12 May 2020).
[15] Although the issue is beyond the scope of this paper, it is important to acknowledge ongoing debate around the equity implications of carbon offsets and trading mechanisms (including REDD+), and the extent to which these support or undermine climate justice. The debate concerns both the global implications (i.e. historical responsibility for emissions and, in turn, the responsibility of rich countries to reduce emissions at source rather than offset them in developing countries) and the local impacts of offsets (where the varied socio-economic roles of land and forests may be affected by the development of offsets, and where land rights are contested/unclear).

Figure 2: Forest-smart mining tools and approaches



Exploration | **Planning** | **Development** | **Operation** | **Closure**

Commitments
• To implementing the mitigation hierarchy • To no net loss, or to net gain/net positive impact • To protected areas

Impact assessments
• Project-level environmental and social impact assessments (ESIAs) • High-level strategic ESIAs and cumulative impact assessments (between mining and other sectors) • Transboundary impact assessments

Economic assessments
• Recognizing forest values (including the fact that forest values are not always substitutable with mineral values) • Internalizing forest risks in bankability assessments (including the full costs of avoiding, minimizing, mitigating and offsetting activities) • Ensuring the financial and technical feasibility of the project before incurring any forest impacts

Project-level planning
• Environmental management plans (including climate and biodiversity action plans) • Social impact management plan • Development of a mine closure plan as part of ESIA and licence process

Strategic planning
• Integrated/landscape-level planning • Regional development planning • Transboundary cooperation • Mine closure planning, including change of ownership safeguards (with transfer of liabilities and allocated funds) • Allocating human, financial and technical resources (including sufficient funds for liabilities and closure)

Avoiding forest loss and degradation
• Establishment of 'no go' areas within the mine site and along infrastructure routes • Early-stage avoidance in mine and infrastructure design, and infrastructure siting • Conservation (preventing deforestation in protected areas; conservation management zoning)

Minimizing the footprint of mining activity
• Minimizing the areal extent of the mine • Minimizing road and infrastructure construction to avoid the fragmentation of forests and in-migration • Control and closure of access routes formed during exploration and construction • Phased clearance and leaving vegetation within the mine footprint where possible • Minimizing polluting waste, including hydrological pollution • Enhanced water management where forests play a role in water supply • Implementing the strongest safeguards around waste and tailings dams

Restoring the impacts of mining
• Rehabilitation • Securing/leasing lands as conservation areas • Progressive rehabilitation and re/afforestation of mined land • Ecosystem restoration concessions • Post-closure reclamation, rehabilitation and restoration

Offsetting residual forest impacts
• Pure offsetting, e.g. formal, like-for-like offsets to meet no net loss commitments • Compensation, e.g. ecological compensation • Additional investments in forest carbon and/or biodiversity to meet net positive impact commitments • Aggregated offsets

Communities
• Stakeholder consultation at exploration stage • Securing community land tenure and forest rights • Consultation and co-management of forest resources • Investment in community foundations and public–private community partnerships (PPCPs)

Artisanal and small-scale mining (ASM)
• Development of an ASM strategy, including co-existence, formalization, regulation and support • Restoring ASM-impacted areas within area of exploration

Research and learning
• Links with research and academia, including joint monitoring and reporting, and support for research and trials • Establishment of peer-learning platforms

Transparency and disclosure
• Transparency and disclosure • Investor, consumer and civil society engagement

Source: Indicative tools and approaches, drawing upon examples cited in the World Bank's large-scale mining case studies.

3. Finance and Forest Monitoring

This section assesses the extent to which mining's forest impacts are acknowledged by consumers and investors, and integrated into wider corporate climate and sustainability commitments. It also considers the potential for emerging finance mechanisms and forest monitoring systems to encourage forest-smart approaches in the mining sector, and forest protection and restoration more broadly.

Consumer and investor engagement

Consumer and investor engagement around deforestation has focused on the big four 'forest-risk' commodities – namely timber, palm oil, beef and soy. Several international agreements and governance mechanisms guide this engagement. These include the New York Declaration on Forests (NYDF), established in 2014 with the objective of halving deforestation by 2020 and halting it by 2030,[16] and the Amsterdam Declaration on Deforestation, established in 2015 with the aim of eliminating deforestation from agricultural commodity supply chains to the EU.[17] Goal 3 of the NYDF looks beyond forest-risk agricultural commodities to other drivers of deforestation, including mining. However, no mining company has committed to the goals of the NYDF, and the development of data in this space has been slow. To help address this data gap, CDP, an NGO that operates a corporate disclosure system for investors, is now asking mining companies to disclose their forest impacts.[18]

Consumer and investor engagement with the mining sector, meanwhile, has tended to focus on human rights impacts such as those associated with resource-related conflict and child labour in supply chains, and on health, safety and environmental violations including the failure of tailings dams.[19] As awareness of the mineral intensity of renewable energy and other clean technologies has grown, investor engagement with the sector on its climate impacts has also intensified.[20] As Table 1 shows, many mining companies now voluntarily report their GHG emissions and set emissions reduction targets, including in some cases commitments to achieving net-zero emissions by mid-century. Some also assess and disclose climate-related financial risks, in line with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). However, there remains a lack of alignment in how the sector's emissions are defined and communicated, complicating investor engagement. Mining companies tend to focus on scope 1 emissions (typically those incurred directly through fuel use) and scope 2 emissions (i.e. those incurred indirectly through power purchase agreements), and only rarely on scope 3 emissions (i.e. those indirectly

[16] See New York Declaration on Forests (2020), 'Goals', https://forestdeclaration.org/ (accessed 30 May 2020).
[17] See the Amsterdam Declaration, 'Towards Eliminating Deforestation from Agricultural Commodity Chains with European Countries', signed by Denmark, France, Germany, Italy, the Netherlands, Norway and the UK, https://ad-partnership.org/wp-content/uploads/2018/10/Amsterdam-Declaration-Deforestation-Palm-Oil-v2017-0612.pdf (accessed 23 Mar. 2020).
[18] CDP (2020), 'Our forests work', https://www.cdp.net/en/forests#Mining (accessed 12 May 2020).
[19] The Church of England Pensions Board (2020), 'Investor Mining and Tailings Safety Initiative', https://www.churchofengland.org/investor-mining-tailings-safety-initiative (accessed 30 May 2020).
[20] Activist investors have raised climate change issues on the agendas at the annual general meetings of major mining companies. See Share Action (2018), 'Shareholder revolt at Rio Tinto's London AGM over "outright climate hypocrisy"', press release, 11 April 2018, https://shareaction.org/shareholder-revolt-rio-tinto/ (accessed 12 May 2020); and Lewis, B. and Jessop, S. (2019), 'Top-5 BHP investor Aberdeen Standard piles on climate pressure ahead of AGM', Reuters, 9 October 2019, https://www.reuters.com/article/us-bhp-agm-church-of-england/top-five-bhp-investor-aberdeen-standard-piles-on-climate-pressure-ahead-of-agm-idUSKBN1WO1GJ (accessed 12 May 2020).

incurred along the supply chain, such as through transport).[21] The recently launched Coalition on Materials Emissions Transparency (COMET) initiative is developing methods to more accurately and consistently calculate and communicate climate impacts along the supply chain,[22] building upon the work of the Greenhouse Gas Protocol and the Science Based Targets initiative (SBTI).

The impacts of mining and its associated infrastructure on land-use change – including forest loss and degradation – do not typically feature in corporate climate policy or reporting. Forest impacts tend to be addressed at the project level instead, through environmental and social impact assessments (ESIAs) and environmental management plans to manage these impacts, which are typically required by law. These assessments, by their nature, are context-specific. They generally focus on direct impacts, and the environmental and socio-economic implications of these impacts, at and around the mine site. The indirect forest loss and degradation that account for most of the sector's forest impacts often fall beyond the scope of ESIAs. The emissions associated with forest impacts are not typically accounted for in ESIAs, and at an aggregate level there remains no comprehensive assessment of the mining sector's contribution to emissions through land-use change and deforestation. As a result, there is a disjuncture between top-down company climate commitments and bottom-up environmental efforts.

> The impacts of mining and its associated infrastructure on forests do not typically feature in corporate climate policy or in climate-related financial disclosures. Forest impacts tend to be addressed at the project level instead.

Where mining companies make voluntary climate commitments, these often include both mitigating and offsetting activities. For capital-intensive sectors with large-scale infrastructure requirements and long asset lifespans, offsetting may seem cheaper and easier than reducing operational emissions in the short term. The concept of engagement in voluntary carbon markets as a 'bridge' to more ambitious climate commitments is gaining traction, and is likely to attract even more interest as pressure on business grows to commit to net-zero emissions by 2050.[23] Several voluntary carbon standards focus on verifying offset projects and their emissions reductions,[24] but transparency along the supply chain and in emissions reporting remains limited. There is no easy way of tracing a carbon credit from the supplier (i.e. the project generating it) to the buyer (the company retiring it), and there is considerable variation in how companies report the use of offsets, with some providing net emissions reductions rather than disaggregated data. Greater transparency, and a clear link to operational and value chain emissions, is urgently needed if growing engagement in voluntary carbon markets is to raise climate ambition and facilitate investment in forests rather than provide a 'get-out clause' for companies that are unable or unwilling to decarbonize at the speed and scale required.[25]

[21] BHP became the first mining company to set scope 3 emissions targets in July 2019. See Hume, N. (2019), 'BHP to set targets for reducing customers' carbon emissions', *Financial Times*, 23 July 2019, https://www.ft.com/content/90b8fdd0-ac87-11e9-8030-530adfa879c2 (accessed 23 Mar. 2020). Vale followed in December 2019, announcing scope 3 targets in shipping and steelmaking. See Hume, N. (2019), 'Vale to set 'Scope 3' emission targets', *Financial Times*, 2 December 2019, https://www.ft.com/content/00392aec-152c-11ea-8d73-6303645ac406 (accessed 12 May 2020).

[22] COMET (the Coalition on Materials Emissions Transparency) is an alliance between MIT's Sustainable Supply Chains initiative, the Columbia Center for Sustainable Investment, the Rocky Mountain Institute and the Colorado School of Mines. See https://rmi.org/our-work/industry-and-transportation/material-value-chains/comet (accessed 12 May 2020).

[23] World Economic Forum (WEF) (2020), 'World Economic Forum asks all Davos participants to set a net-zero climate target', 17 January 2020, https://www.weforum.org/agenda/2020/01/davos-ceos-to-set-net-zero-target-2050-climate/ (accessed 12 May 2020).

[24] These include the Gold Standard founded by WWF and other international NGOs in 2003, https://www.goldstandard.org/impact-quantification/carbon-markets (accessed 12 May 2020); and Verra, founded by the International Emissions Trading Association (IETA) and the WEF, along with its Verified Carbon Standard (VCS) Programme, https://verra.org/project/vcs-program/ (accessed 12 May 2020).

[25] It should be noted that offsets are not currently allowed as a mechanism to meet science-based targets.

Table 1: Climate mitigation targets and climate-related forest commitments, selected mining and metals companies

Company[26]	Mines in forest areas (MFAs)[27]	Emissions (MMt2Coe)[28]	Climate mitigation targets	Scope 1, 2, 3	Climate-related forest commitments[29]
Alcoa	82%/ 9 of 11	24.3	Reduce GHG emission intensity **by 30% by 2025**; **by 50% by 2030** (from 2015 levels).	1, 2	Tree planting partnership with American Forests to 'enhance biodiversity and combat climate change' in 13 locations globally; exploring REDD+ opportunities.
Anglo American	18%/ 13 of 74	17.7	Reduce GHG emissions by **30% by 2030** (from 2016 levels); **carbon neutrality by 2040**.	1, 2	'Exploring options for offsets, should there be a potential exceedance, including carbon credits.'
ArcelorMittal	67%/ 17 of 30	194 (nine from mining)	Reduce CO_2 emissions by 30% by 2030 (from 2018 levels) (European business); carbon neutral by 2050 (group-wide).	1, 2	No stated role.
Barrick Gold	20%/ 9 of 45	7.5	Reduce GHG emissions by **at least 10% by 2030** (from 2018 levels).	1, 2	No stated role.
BHP	13%/ 6 of 47	15.8	Reduce scope 1 and 2 GHG emissions by **at least 30% by 2030** (from 2020 levels); scope 3 goals set for steelmaking and shipping.	1, 2, 3	Carbon offsets 'will be used as required'; support for REDD+ including investing in the Alto Mayo Conservation Initiative in Peru and IFC Forests Bond in Kenya (see Box 1); carbon offset strategy developed in 2020 and integrated in climate policy.
First Quantum	67%/ 8 of 12	3.3	None stated.		Not applicable.
Glencore	26% / 30 of 117	29.2	Reduce carbon intensity by **5% by 2020** (from 2016 levels); longer-term targets to be announced in 2020.	1, 2	No stated role at portfolio level; purchase of REDD+ Pacific certificates at project level, to offset the emissions of the Prodeco coal mine in Colombia.
Newmont	28%/ 11 of 47	3.55	Reduce carbon intensity by **16.5% by 2020** (from 2018 levels); 'assessing pathways in line with science-based targets for 2030' in 2020.	1, 2	Forestation projects in Peru to improve the salinity of soil, mitigate Yanacocha copper mine's GHG emissions, and increase biodiversity; tree plantations in Australia, managed by CO_2 Australia and issuing Australian Carbon Credit Units.
Rio Tinto	27%/ 12 of 45	31.8	Reduce GHG emissions by **15% by 2030** (from 2018 levels); to **net zero by 2050**.	1, 2	Carbon removals and offsets will form part of Rio Tinto's decarbonization strategy; from 2020, evaluating the potential to implement natural climate solutions at sites.
RUSAL	87%/ 13 of 15	39.2	No portfolio-wide target; strategic goals for GHG emissions reductions (e.g. renewable energy use, smelting emissions) to 2025.	1, 2	Plans to plant over 1 million trees in Russia, as part of its climate strategy, to reduce the company's carbon footprint; intention to offset the remaining GHG emissions that make up the full carbon footprint of RUSAL's primary aluminium products.
Vale	91%/ 74 of 81	12.6	Reduce scope 1 and 2 GHG emissions by **33% by 2030** (from 2017 levels) 'in line with Science Based Targets'; become **carbon-neutral by 2050**; scope 3 goals to be defined.	1, 2, 3	'Remaining emissions can be offset through reforestation of degraded areas or purchase of carbon credits'; will 'recover and protect more than 500,000 hectares of native forests by 2030' as part of Vale's 'New Pact with Society'.

[26] Companies included within the World Bank study on the impacts of large-scale mining on forests. See World Bank (2019), *Making Mining Forest-Smart*, Executive Summary Report, p. 34.
[27] MFA data from World Bank (2019), *Forest-Smart Mining: Identifying Factors Associated with the Impacts of Large-Scale Mining on Forests*.
[28] Emissions data and climate mitigation targets from latest company sustainability and/or climate reports. Emissions for Arcelor Mittal, Barrick and Rio Tinto for 2018, all others 2019 (covering scope 1 and 2).
[29] Climate-related forest commitments, as described in company sustainability and/or climate reports, unless otherwise stated.

Sources for Table 1: **Alcoa:** Alcoa (2019), 2019 *Alcoa Sustainability Report*, https://www.alcoa.com/sustainability/en/pdf/2019-Sustainability-Report.pdf (accessed 28 Sep. 2020) – **Anglo American:** Anglo American (2019), *Sustainability Report 2019*, https://www.angloamerican.com/~/media/Files/A/Anglo-American-Group/PLC/investors/annual-reporting/2020/aa-sustainability-report-2019-v1.pdf (accessed 24 Sep. 2020); Anglo American (2020), 'Climate Change & Mining', https://www.angloamerican.com/sustainability/environment/climate-change (accessed 24 Sep. 2020); CDP (2019), *Anglo American – Climate Change 2019*, https://www.angloamerican.com/~/media/Files/A/Anglo-American-Group/PLC/sustainability/approach-and-policies/sustainability/performance/anglo-american-climate-change-response-2019.pdf (accessed 23 Sep. 2020) – **ArcelorMittal:** ArcelorMittal (2020), 'ArcelorMittal sets 2050 group carbon emissions target of net zero', press release, 30 September 2020, https://corporate.arcelormittal.com/media/press-releases/arcelormittal-sets-2050-group-carbon-emissions-target-of-net-zero (accessed 30 Sep. 2020); ArcelorMittal (2019), 'ArcelorMittal Europe sets target to cut carbon emissions by 30% by 2030, to contribute to the European Commission's Green Deal', press release, 13 December 2019, https://corporate.arcelormittal.com/media/news-articles/2019-dec-13-arcelormittal-europe-sets-target-to-cut-carbon-emissions-by-30-by-2030 (accessed 28 Sep. 2020) – **Barrick Gold:** Barrick Gold (2019), *Sustainability Report 2019*, https://s25.q4cdn.com/322814910/files/sustainability/Barrick-Sustainability-Report-2019.pdf (accessed 21 Sep. 2020) – **BHP:** BHP (2020), *Climate Change Report 2020*, https://www.bhp.com/-/media/documents/investors/annual-reports/2020/200910_bhpclimatechangereport2020.pdf (accessed 21 Sep. 2020) – **First Quantum:** First Quantum (2019), *Environment, Safety and Social Data Report* 2019, https://s24.q4cdn.com/821689673/files/doc_downloads/environmental-health-and-safety/2019-Environment-Safety-Social-Data-Report-Optimised.pdf (accessed 28 Sep. 2020) – **Glencore:** Glencore (2019), *Sustainability Report 2019*, https://www.glencore.com/dam/jcr:31236b6f-34a4-432a-b4b3-6fe133488bb8/2019-Glencore-Sustainability-Report-.pdf (accessed 23 Sep. 2020); Glencore (2020), 'Glencore's commitment to the transition to a low-carbon economy', press release, 18 February 2020, https://www.glencore.com/media-and-insights/news/glencores-commitment-to-the-transition-to-a-low-carbon-economy (accessed 24 Sep. 2020); Grupo Prodeco (2018), 'Prodeco Group Interested in the Purchase of Coal Certificates to Mitigate Climate Change', http://www.grupoprodeco.com.co/es/sala-de-prensa/grupo-prodeco-informa/prodeco-group-interested-purchase-coal-certificates-mitigate-climate-change/ (accessed 29 Sep. 2020) – **Newmont:** Newmont (2019), *2019 Sustainability Report: Beyond the Mine*, https://s24.q4cdn.com/382246808/files/doc_downloads/2019/sustainability/Newmont-2019-sustainability-report.pdf, (accessed 29 Sep. 2020); Newmont (2017), 'Energy & Climate Change: Newmont's Carbon Offset and Emissions Reduction Projects', Newmont Blog, 16 November 2017, https://www.newmont.com/blog-stories/blog-stories-details/2017/Energy--Climate-Change-Newmonts-Carbon-Offset-and-Emissions-Reduction-Projects/default.aspx (accessed 29 Sep. 2020) – **Rio Tinto:** Rio Tinto (2019), *2019 Climate Change Report*, https://www.riotinto.com/en/sustainability/climate-change (accessed 29 Sep. 2020) – **RUSAL:** RUSAL (2019), *Reducing Impact for the Green Future: Sustainability Report 2019*, https://rusal.ru/upload/iblock/140/14003c814dca975bcb2622ae35cb2cf0.pdf (accessed 29 Sep. 2020); Bloxsome, N. (2019), 'RUSAL: Sustainable efforts', *Aluminium International Today*, 1 April 2019, https://aluminiumtoday.com/news/rusal-sustainable-efforts (accessed 29 Sep. 2020) – Vale (2019), *Sustainability Report 2019*, http://www.vale.com/EN/investors/information-market/annual-reports/sustainability-reports/Sustainability%20Reports/Relatorio_sustentabilidade_vale_2019_alta_en.pdf (accessed 29 Sep. 2020).

Investing in forest protection and restoration

It is within this context that forest finance has emerged as a tool of climate policy in the mining sector, as well as in other carbon-intensive and heavy industrial sectors.[30] Engagement in the United Nations Framework Convention on Climate Change (UNFCCC) REDD+ programme and other mechanisms that generate forest-based carbon credits can give the relevant companies access to voluntary carbon markets and, in some cases, mandatory carbon markets.[31] Well-managed land-based and forest-based offsets may also deliver co-benefits for sustainable livelihoods, biodiversity and other UN Sustainable Development Goals (SDGs), support for which is central to the mining sector's social licence to operate. However, the need for transparency is particularly great where forest carbon is concerned, given the long-term policy and financial support required to ensure the permanence of forest carbon assets, and the serious challenges associated with verifying the equivalence and permanence of forest carbon, particularly in settings where government capacity is weak. The limited supply of high-quality forest carbon projects has encouraged some companies to take a more active role in REDD+ and in the development of innovative forest finance mechanisms (see Box 1).

[30] Interest is growing across carbon-intensive sectors. However, a clear distinction should be drawn between those who see offsets as a tool in their transition to a decarbonized business model and those who plan to invest in forests in order to support an unsustainable business model reliant on continued anthropogenic emissions. This paper focuses on the former.

[31] New Zealand's ETS is the only mandatory market that currently allows forest-based credits. There is, for example, ongoing debate about whether REDD+ credits should be allowed under California's emissions trading mechanism. The EU, which has always excluded forest credits, has warned against this. See Fern 25 (2019), 'Forest offsets: California on the brink of a serious mistake', 8 May 2019, https://www.fern.org/news-resources/forest-offsets-california-on-the-brink-of-a-serious-mistake-973 (accessed 12 May 2020).

Investing in the protection of forests and in reforestation and afforestation is potentially one of the most cost-effective tools in emissions mitigation.[32] Forests and other natural climate solutions could provide up to one-third of the emissions reductions required by 2030 to hold global warming well below 2°C.[33] Current investment in forests remains grossly inadequate to this task, accounting for around 2 per cent of all climate finance.[34] The UNFCCC established the REDD+ programme in 2008, with the objective of encouraging private sector finance into forests by generating tradeable carbon credits.[35] Progress on implementation has been slower than anticipated, and REDD+ remains almost wholly reliant on bilateral and multilateral donor funding.[36] This is partly because forests have little value as conventional financial assets, with neither their varied contribution to livelihoods and economic development nor their value in carbon and biodiversity terms fully reflected in the price of forest assets. As a result, REDD+ and other forest finance mechanisms have effectively lacked a demand side, and many are now at risk of collapse.

At the same time, mainstream financial investors are seeking green investment opportunities. There is a fast-evolving ecosystem of sustainable finance mechanisms, designed to support green and environmental, social and governance (ESG) outcomes. The green bond market is now worth over $1 trillion, and is among the most prominent entry points for investors.[37] It includes a growing number of sovereign green bonds that feature forests among their proceeds: Poland has issued three sovereign bonds since 2016 designed to support renewable energy, the country's shift away from coal, and afforestation and national parks, among other areas; Nigeria became the first African country to issue a sovereign green bond in 2017, with proceeds earmarked for renewable energy and afforestation. Thematic forest finance mechanisms are also emerging, including the International Finance Corporation (IFC)'s Forests Bond, alongside other innovative forest finance concepts (see Box 1). So too are corporate ESG and green bonds within the mining and steel sectors: South Korean steelmaker POSCO issued the steel sector's first ESG bond in mid-2019,[38] and Swedish iron ore mining company LKAB launched its first green bond later in the same year.[39]

There may be opportunities for countries and companies to leverage emerging green and forest finance mechanisms to support forest-smart approaches to mining. At the same time, there remain serious questions about how to effectively value, protect and finance forests, and how best to measure the success of such mechanisms in advancing their stated goals. Key questions include (a) the financing mechanism and the appropriate mix of public and private finance; (b) the appropriate

[32] IPCC (2019), *Special Report on Climate Change and Land*, https://www.ipcc.ch/srccl-report-download-page/ (accessed 12 May 2020).
[33] Griscom, B. W. et al. (2017), 'Natural Climate Solutions', *PNAS*, October 31, 2017 114 (44) 11645-11650; first published 16 October 2017, https://doi.org/10.1073/pnas.1710465114 (accessed 30 May 2020).
[34] According to the Climate Policy Initiative, $7 billion was given to agriculture, forestry and land use in 2018, which was just under 2 per cent of total funding for climate mitigation. See Buchner, B., Clark, A., Falconer, A., Macquarie, R., Meattle, C., Tolentino, R. and Wetherbee, C. (2019), *Global Landscape of Climate Finance 2019*, London: Climate Policy Initiative, p. 30, https://climatepolicyinitiative.org/wp-content/uploads/2019/11/GLCF-2019.pdf (accessed 12 May 2020). The *Finance for Forests* report, from the NYDF Progress Assessment, finds that only 2 per cent of $167 billion in international development finance committed from 2010 to 2015 to reduce carbon emissions went to protecting and restoring forests. See Climate Focus (2017), *Progress on the New York Declaration on Forests: Finance for Forests – Goals 8 and 9 Assessment Report*, https://forestdeclaration.org/images/uploads/resource/2017_NYDF_Goal8-9-Assessment_Full.pdf (accessed 12 May 2020).
[35] REDD+ stands for 'reducing emissions from deforestation and forest degradation'. The mechanism emphasizes the role of conservation, sustainable management of forests and the enhancement of forest carbon stocks in developing countries.
[36] For a summary of progress to date, see UN-REDD (2018), *10th Consolidated Annual Progress Report of the UN-REDD Programme Fund*, https://www.unredd.net/documents/programme-progress-reports-785/2018-programme-progress-reports/17258-un-redd-consolidated-2018-annual-report.html?path=programme-progress-reports-785/2018-programme-progress-reports (accessed 12 May 2020).
[37] Bloomberg (2020), 'Record Month Shoots Green Bonds Past Trillion-Dollar Mark', Bloomberg NEF, 5 October 2020, https://about.bnef.com/blog/record-month-shoots-green-bonds-past-trillion-dollar-mark/ (accessed 9 Oct. 2020).
[38] Hu, T. (2019), 'More metals, mining companies expected to issue ESG bonds', S&P Global Market Intelligence, 23 July 2019, https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/52997113 (accessed 1 Aug. 2020).
[39] Adeeb, M. (2019), 'Swedish iron ore miner LKAB issues 1st green bond of 2B kronor', S&P Global Market Intelligence, 29 November 2019, https://www.spglobal.com/marketintelligence/en/news-insights/trending/gqkbwwsvortb4ewdndjovg2 (accessed 1 Jun. 2020).

indicators of success for mitigating, compensatory and additional efforts; and (c) how to monitor and verify performance. Multilateral development banks (MDBs) and other issuers can play an important role here, developing and testing innovative finance mechanisms and their indicators of success, de-risking these mechanisms with concessional finance and guarantees, and providing countries and companies with technical assistance on the development of measurement, reporting and verification (MRV) systems.

Box 1: Forest bonds and innovative forest finance mechanisms

Finance 4 Forests (F4F) is a partnership and knowledge-sharing platform, founded by the NGO Conservation International, the mining company BHP and the law firm Baker McKenzie. F4F's objective is to further private sector understanding of REDD+ and encourage market participation in forest finance.

Building upon the work of F4F, BHP worked with the IFC to develop the inaugural IFC Forests Bond, which generates carbon credits. The bond was designed to attract institutional finance and non-traditional blue-chip investors (i.e. carbon investors) by creating a mainstream forest finance product and providing a financial guarantee to de-risk it. The resulting product is an IFC-issued, triple A-rated, five-year bond with a 1.2 per cent interest rate. Investors have the option of taking the verified carbon units (VCUs) generated by the project and using them for compliance, selling them into the market, or cashing in the VCUs at a guaranteed $5 strike price, with BHP committing to buy them back. So far investors have cashed in their VCUs, reflecting their status as financial investors looking for a return, rather than carbon investors looking for offsets.

F4F has since developed several other forest finance 'concepts', including:

- **A 'Forests bond 2.0'.** Building upon the original IFC Forests Bond, this initiative explores different ways of structuring the bond, with varying levels of risk and return for investors.
- **Paris debt-for-climate swaps.** This US government-backed, results-based payment model involves the release of debt in exchange for protecting forests (in effect, it is a reconfiguration of traditional debt-for-nature swaps, wherein indebted countries receive debt relief in return for investing some of the savings in REDD+ activities).
- **Forests-for-climate investment funds.** This concept involves a dedicated investment facility that aggregates and deploys investment capital towards the establishment and development of REDD+ projects and activities. Such vehicles have yet to attract private sector investment and remain primarily official development assistance (ODA) instruments.
- **NDC forest bonds.** Some governments are reportedly keen to develop 'NDC bonds', which could be structured like sovereign green bonds, with payments linked to the relevant country's performance against its Nationally Determined Contribution (NDC). Forest protection would be achieved through REDD+, with finance raised via the NDC bond plus public–private partnerships.
- **'Article 6' transfers.** This concept is named after Article 6 of the Paris Agreement, and would entail mitigation activity in one jurisdiction being transferred and counted in another jurisdiction through REDD+ or an internationally transferred mitigation obligation (ITMO). The process would require transfer and purchase agreements between the host (credit-generating) country, the support (credit-receiving) country and the private sector off-taker (in the support country). It remains unclear exactly how such instruments would work following the failure to reach an agreement around Article 6 of the Paris Agreement – which establishes the rules for international carbon trading – at the 25th UN Conference of the Parties (COP25) in Madrid in 2019.

Based on discussions at the research workshop 'The Role of Innovative Technologies and Finance in Advancing Forest-Smart Mining', held at Chatham House on 10 May 2019, and the white paper Finance 4 Forests (2019), *Innovative Investment Mechanism Concepts to Finance Forests as a Climate Solution*, Conservation International and Baker McKenzie.

The role of forest monitoring systems

As well as helping to channel finance to forests, engagement with REDD+ and other forest finance mechanisms may enhance forest information and monitoring systems and help strengthen forest governance. Robust systems for monitoring the forest and land-use sectors are critical tools for enabling governments to develop and implement effective climate strategies and leverage international finance for forests. As part of their wider forest and climate commitments, many countries are establishing forest MRV systems for REDD+ and other schemes, with bilateral support from Germany, Norway and the UK, among others, and multilateral support from UN-REDD and programmes such as the World Bank-managed Forest Carbon Partnership Facility (FCPF). REDD+ is a form of results-based finance, and to access it countries must establish the following: first, a national REDD+ strategy; second, a national forest monitoring system (NFMS) including satellite information, forest inventory, a forest information system and community monitoring; third, a safeguards information system (SIS); and fourth, a forest reference level (FRL) or forest reference emission level (FREL).

These data and systems could support more strategic approaches to mitigating the impacts of mining and other drivers of deforestation, as they could encourage landscape- or jurisdictional-level planning rather than management of forest impacts on a project-by-project basis. The convergence of mining, forest and carbon interests should in theory help to address issues – including the impact of mining on forests – that have traditionally fallen between silos. For example, where governments are tackling deforestation at multiple levels, there may be opportunities to incorporate the net residual impacts[40] of mining and other economic drivers of deforestation into forest finance mechanisms such as REDD+, and to aggregate offsets that can protect large areas of forest. There may also be potential to combine higher-value carbon offsets and lower-value biodiversity offsets at the landscape level. In this context, REDD+ could help to incentivize climate mitigation efforts and the protection of biodiversity, and encourage the reclamation, rehabilitation and restoration of land where mining is under way.

The provision of a nationally recognized monitoring system for forest impacts may also help to enhance transparency and accountability for companies and other stakeholders, as well as facilitating their access to carbon markets. Effective MRV may help to support GHG accounting for the mining sector, and aid tracking of the direct and indirect forest impacts of mining investments (in terms of net loss/net gain of forest cover) and their associated GHG impacts. The vast quantities of data generated by REDD+ infrastructure may also be of great value to investors, consumers and civil society, especially in the context of growing engagement with the mining sector on its ESG performance. However, access to such data is currently inconsistent, with each country deciding its own disclosure arrangements. Donors and MDBs could support a more consistent approach here, helping countries overcome policy and practical barriers to data-sharing, as well as supporting the development of common standards and platforms that could make data more widely available, and of practical use to investors, consumers and civil society.

[40] In other words, the remaining impacts after all other efforts to avoid and reduce forest loss and degradation.

4. Forest-smart Approaches

There are several areas of opportunity to better address the impacts of mining on forests. These range from interventions that directly address forest risks and impacts, to those that support the wider conditions for forest-smart approaches *and* the wider transition to more sustainable, zero-carbon mining and minerals supply chains. This section signposts these areas of opportunity at country, company and sector level.

Country level

Effective governance remains the first line of defence against mining-induced forest loss and degradation. Ensuring that existing legislation and regulations are enforced is crucial, yet this remains a real challenge for many countries with limited resources, weak institutions and wavering political will, particularly where environmental protection and climate commitments are perceived as being in opposition to urgent economic development needs. The full value of forests in socio-economic and ecosystem terms is rarely recognized or factored into decision-making around the sector. Where conflicts between protecting forests and supporting mining are evident, high-value mineral resources tend to win out.

Mining and forest governance frameworks

Where mining presents forest risks, a reassessment of the policy and regulatory frameworks that guide the sector is warranted. These frameworks should address the mining sector's forest impacts (and the emissions and biodiversity implications of those impacts) throughout the project cycle. Particular attention should be paid at the beginning and the end of the project cycle, where some of the greatest opportunities for forest protection, reforestation and afforestation are likely to arise. Bilateral donors and MDBs should explore how their policy and technical assistance can help.

As noted in Section 2, forest-smart approaches will be most effective when they are designed into projects from the outset. Relatively few large mines came online in the years following the commodities price crash of 2014, and those that did were often in 'safe haven' OECD jurisdictions. More recently, the development of mega-mines such as the Simandou iron ore project in Guinea has resumed, and despite relatively low exploration budgets, investor interest in 'rest of the world' locations (ex-Canada and Australia) is increasing, including in many forest-rich developing countries such as the DRC and Ecuador.[41]

Declining ore grades across the sector may lead to an expansion in mining and, in turn, the scale of land-use change and forest impacts. Such declines may also incentivize exploration and mine development in forest landscapes where there is a prospect of discovering and developing higher-grade ores. This suggests the need to review regulatory frameworks and licensing practices for new mines in forest landscapes, including strengthening ESIAs and ensuring that the value

[41] S&P Global Market Intelligence (2020), *World Exploration Trends*, March 2020, https://pages.marketintelligence.spglobal.com/rs/565-BDO-100/images/World%20Exploration%20Trends%20Report%202019-final.pdf (accessed 1 Jun. 2020).

of forests is recognized, and that forest risks (and the full costs of avoiding, minimizing, restoring and offsetting them) are internalized in economic assessments. It also suggests the need for higher-level, strategic impact assessments that can coordinate ESIAs in mining and other sectors, and that can support integrated approaches at landscape, national and regional level.

Where mines have been in operation for decades, and where they were not designed with forest preservation in mind, opportunities to implement tools at the upper end of the mitigation hierarchy will naturally be limited, as well as more expensive and technically challenging. However, the decommissioning, rehabilitation and restoration of mine sites may still present significant opportunities for reforestation and afforestation, and in some instances the opportunity to repurpose mine sites for alternative socio-economic uses. Many large-scale mines are due to be decommissioned in the coming decades, yet the forest potential of mined land does not typically feature in minerals governance regimes where these relate to mine closure requirements. The regulatory and policy regimes that guide the mining sector should consider the forest potential of mined land and how locally appropriate reforestation or afforestation measures could be incorporated into the design of mine closures.

National climate commitments and SDGs

Situating mining sector development within the wider context of national climate and sustainable development planning is crucial. Moving beyond project and sector approaches will be particularly important where the indirect and cumulative impacts of mining are concerned. Such approaches will require the coordination and financing of integrated, landscape-level planning, potentially through REDD+ and other forest finance mechanisms where locally appropriate. Securing the requisite political commitment for such approaches remains challenging, especially where the economic value of forests appears relatively low compared to that of mineral resources. NDCs and long-term national emissions reduction strategies to 2050 can help reinforce the value of forests, and provide a clear mandate for governments to avoid mining-linked forest loss and degradation, as well as setting targets for reforestation and afforestation. National sustainable development plans may also help raise awareness around the varied ecosystem services and socio-economic roles that forests play, and the value of protecting and investing in them. Key questions include the following:

- What is the likely impact of mining and its associated infrastructure on the delivery of NDCs and long-term strategies to 2050, given the sector's emissions (including those associated with deforestation and forest degradation)?
- Could climate targets for the mining sector – ensuring no net loss of forest carbon or ensuring net gain, alongside the wider decarbonization of mining activities – be incorporated within NDCs and national sustainable development plans?
- What policy and regulatory frameworks (particularly those relating to minerals and forest governance) and institutional capacities are required to implement such commitments at national and subnational level?
- Where are the investment gaps for forest-smart mining and for NDC and SDG delivery more broadly, and where are the entry points for companies and private sector investors, including through REDD+ and emerging green and forest finance mechanisms?

Countries with a high dependency on mining and a high vulnerability to forest impacts would benefit from national roadmaps for more sustainable mining. Some of these countries, such as the DRC, Guinea and Zambia, account for a significant or growing share of global production of certain minerals. Potentially, these countries have the international profile to become model examples of forest protection through the integration of land-use change and forest impacts into mining policy. At both national and subnational levels, integrated planning and enhanced monitoring can help minimize forest loss and degradation resulting from mining and economic drivers. Such processes may also support jurisdictional approaches to forest finance, which may help address any residual forest impacts, and aggregate these impacts into REDD+ and other mechanisms with the potential to attract private as well as public finance.[42] Where critical forest landscapes overlap national borders, as in the Amazon, West Africa and the Congo Basin, for instance, collaborative approaches may be required to monitor mining activity and safeguard forests both within and between jurisdictions.

Company level

Companies are facing increasing demands from their shareholders and other stakeholders to disclose climate-related risks under the TCFD, and to set out how they will transition to a Paris-aligned business model. Demonstrating credible progress will be important to the mining sector's continued social licence to operate. Emissions relating to deforestation are not part of standard climate disclosures under the TCFD, and mining companies have yet to draw direct links between their climate commitments and their forest impacts at the operational level. Better understanding of the sector's forest impacts and associated emissions will be crucial to effective investor engagement. Assessments should incorporate both the loss of forest carbon stocks due to mining and linked infrastructure and the gains through reforestation and afforestation. The Greenhouse Gas Protocol is developing standards and guidance for corporate reporting of land-use change and carbon removals, which may assist in this.[43] Mining and consumer companies should also consider aligning offsets with their impacts, and investing in forests in the country or region of operation.

Progress on the disclosure of impacts on biodiversity and other areas of natural capital, such as land and water, lags by comparison. Where particularly valuable or vulnerable ecosystems are concerned, the relative impact of mining on biodiversity may be far greater than its impact on climate change. Yet incorporating biodiversity into policy development and decision-making at the corporate level remains difficult, given the bottom-up nature of assessments, the context-specific nature of impacts, and the relative absence of reporting frameworks for nature-based disclosures. Momentum for the development of both climate- and nature-related financial disclosures is now growing rapidly, particularly in the EU,[44] and a Taskforce for Nature-related Financial Disclosures (TNFD) is being developed ahead of COP26 by a coalition of NGOs, banks and governments.[45] Where the economic value of carbon offsets is relatively higher than that of biodiversity offsets, there may be opportunities for REDD+ and other forms of forest carbon finance to generate revenue streams that contribute

[42] This reflects the wider trend away from project-level REDD+ schemes towards comprehensive, government-led jurisdictional approaches to forest and land use at state or sub-state level and potentially 'nested' approaches, where REDD+ projects can contribute and where the risk of carbon leakage can be minimized.
[43] Greenhouse Gas Protocol (2019), 'New Greenhouse Gas Protocol Standards/Guidance on Carbon Removals and Land Use', 15 October 2019, https://ghgprotocol.org/blog/new-greenhouse-gas-protocol-standardsguidance-carbon-removals-and-land-use (accessed 12 May 2020).
[44] See, for example, Climate Disclosure Standards Board (2020), 'Enhancing nature-related financial disclosures in mainstream reports across Europe and beyond', https://www.cdsb.net/what-we-do/enhancing-nature-related-financial-disclosures-mainstream-reports-across-europe-and (accessed 12 May 2020).
[45] Global Canopy (2020), 'Bringing Together a Taskforce on Nature-related Financial Disclosures', Global Canopy, UNDP, UNEP-FI, WWF, 21 July 2020, https://tnfd.info (accessed 31 Jul. 2020).

to the protection of local ecosystems and the delivery of biodiversity targets. Such approaches may also help ensure that forest impacts are addressed at project and jurisdictional level, rather than offset elsewhere.

> Wherever mining has an impact on forests, the principles of good corporate policy should include clear commitments to no net loss of forest cover, no net loss of biodiversity, and net-zero GHG emissions (or even net removals, for example through reforestation and afforestation).

Wherever mining has an impact on forests, the principles of good corporate policy should include clear commitments to no net loss of forest cover, no net loss of biodiversity, and net-zero GHG emissions (or even net removals, for example through reforestation and afforestation). The development of integrated frameworks for assessing climate, forest and other impacts could aid assessment of the mining sector's progress against such commitments in a more comprehensive way. With most mining companies accepting responsibility for direct forest impacts, and many now reporting and setting targets for scope 1 and 2 emissions, there is already a solid foundation on which to build the links between forest impacts at project level and associated emissions at the climate policy level. One obvious entry point is the incorporation of land-use change and net forest carbon losses/gains in GHG reporting. As companies begin to address their scope 3 emissions, there should also be scope to incorporate indirect forest impacts, such as those relating to infrastructure, and to consider the partnerships and mechansims that would be required to address them.

Sector level

Analysis of the concentration of supply and demand in certain mineral markets and each country's vulnerability to forest impacts could help identify supply chains and countries in need of further attention. A 2014 paper by Chatham House found that most minerals production (by volume) is concentrated in just 11 countries: four OECD countries (Australia, Canada, Chile and the US) and seven emerging markets (Brazil, China, India, Indonesia, Peru, Russia and South Africa). For some supply chains, this concentration of production is pronounced: Australia and Brazil account for more than 70 per cent of global iron ore exports, the DRC for more than 80 per cent of cobalt exports, and Chile for more than one-third of copper exports. Among the developing countries that have received large-scale greenfield mining investments in recent years, only Zambia and Guinea were projected to become 'major' producers providing more than 5 per cent of world supply (for copper and iron ore respectively).[46] Several of the major producers, as well as Zambia and Guinea, are among the highest-risk producer countries for forest impacts.

With OECD companies and Chinese enterprises accounting for most global mining investment, efforts to address mining's forest impacts will need to resonate with a wide range of stakeholders. While this paper focuses on the options for companies and countries in terms of reducing forest impacts, and for investor and consumer engagement to encourage this, it acknowledges the limitations of such an approach. For SOEs and more strategic actors, the disclosure and management of mining's forest impacts (alongside wider land, water, climate and biodiversity impacts) will likely be affected

[46] Kooroshy, K., Preston, F. and Bradley, S. (2014), *Cartels and Competition in Minerals Markets: Challenges for Global Governance*, Research Paper, London: Royal Institute of International Affairs, https://www.chathamhouse.org/sites/default/files/field/field_document/20141219CartelsCompetitionMineralsMarketsKooroshyPrestonBradleyFinal.pdf (accessed 12 May 2020).

by more direct mechanisms, including the development of legislation, regulation and case law, and by the implementation of standards and mechanisms that affect access to finance (see Box 2). There is also a need to engage smaller, 'junior' mining companies that explore for, discover and develop mineral deposits in the earliest stages before selling them on, as such firms do not have the same capacities as the major miners. Both cases reinforce the need for robust policy and regulatory frameworks in host countries and markets, and for the institutional capacity to enforce them.

Box 2: China's role in global mining and minerals governance

Few challenges in the mining sector can be addressed without China's engagement. Global metals and minerals trade almost doubled in weight – from 1.8 billion tonnes to 3.5 billion tonnes – between 2000 and 2018, and quadrupled in value from $450 billion to $1.5 trillion over the same period (see Figure 3).[47] China's rising demand was the primary driver of this growth, and was reflected in the emergence of sizeable trade flows of iron ore from Brazil, nickel from Indonesia and the Philippines, and copper from Chile, among others. China now accounts for around half of all metals and minerals trade and consumption, as well as being a major minerals producer in its own right, particularly of rare earth elements (REEs). As the world's largest producer of renewable energy and other clean technologies, China is importing growing volumes of the metals and minerals required to manufacture them. Long-standing concerns about security of supply have driven significant Chinese investments in overseas mining projects, including cobalt mines in the DRC, copper mines in Zambia, and bauxite and iron ore mines in Guinea.[48]

While environmental governance of the mining sector within China has strengthened, discussion of the sector's climate impacts remains limited. Since the 2000s, new environmental regulation has been implemented and environmental impacts have become a factor in financing. For domestic finance, the introduction of the China Banking Regulatory Commission (CBRC)'s Green Credit Guidelines in 2007 created a voluntary framework for ESG reporting. For foreign direct investment (FDI), guidance for outbound investments in the mining sector and due diligence guidelines for responsible minerals supply chains have been developed by the China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters (CCCMC).[49] Guidance on forest impacts has focused on soft commodities, particularly palm oil and rubber.[50] Chinese mining companies increasingly consider ESG reporting part of good risk management and a precondition for access to finance, but reporting remains voluntary and does not typically include GHG emissions or the emissions associated with forest impacts.

China has also taken a leading role in the development of green finance. China's central bank – the People's Bank of China (PBC) – established green finance systems within China and put green finance on the G20 agenda in 2016. China's green finance market has grown to become the world's largest, yet there remain concerns that emerging green finance mechanisms lack clear definitions and metrics of success. They are often designated by sector – such as electric vehicles or batteries – with the aim of increasing capital allocation to green sectors as well as supporting China's economic restructuring towards lower-emission, higher-quality growth. According to the PBC's 2018 national report, the standards, metrics, disclosure and accreditation required for green finance products are still in development. So, too, are the related policies for overseas investment, including in countries involved in China's Belt and Road Initiative (BRI).[51] Ongoing efforts to harmonize sustainable investment and finance standards for the BRI, including through indicators of company 'climate performance' such as emissions reporting and shadow

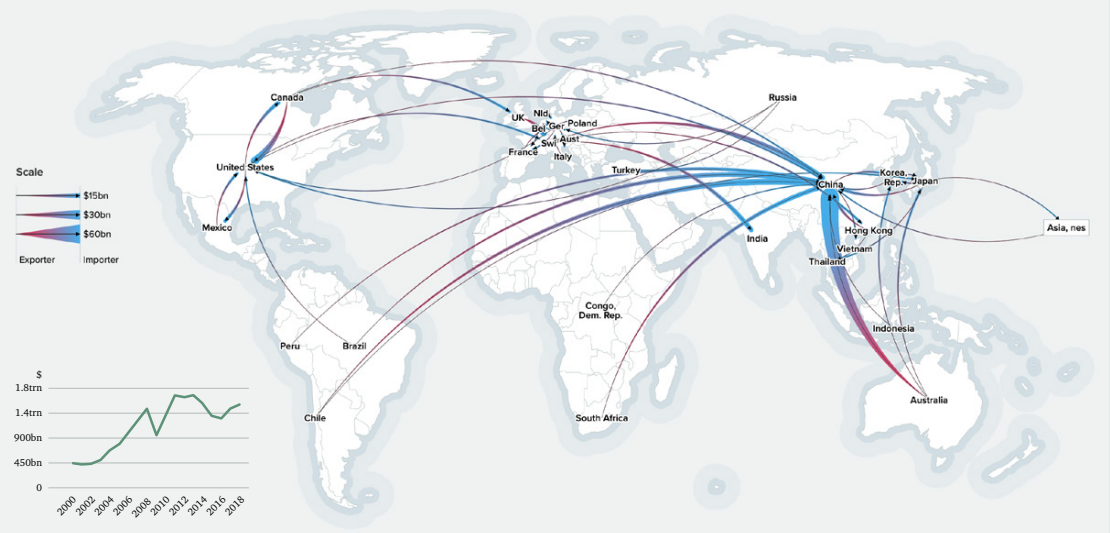
[47] The value of trade peaked at $1.7 trillion in 2012–13, prior to the commodities price crash. See data at Chatham House/UN Comtrade (2020), www.resourcetrade.earth (accessed 12 May 2020).
[48] Preston, F., Bailey, R., Bradley, S., Changwen, Z. and Wei, J. (2016), *Navigating the New Normal: China and Global Resource Governance,* a joint report of Chatham House and the Development Research Centre of the State Council, https://www.chathamhouse.org/publication/navigating-new-normal-china-and-global-resource-governance (accessed 12 May 2020).
[49] See China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters (CCCMC) (2014), *Guidelines for Social Responsibility in Outbound Mining Investments,* http://www.cccmc.org.cn/docs/2014-10/20141029161135692190.pdf (accessed 30 May 2020); and CCCMC (2015), *Chinese Due Diligence Guidelines for Responsible Minerals Supply Chains*, http://www.cccmc.org.cn/docs/2016-05/20160503161408153738.pdf (accessed 30 May 2020).
[50] CCCMC (2017), 'Official release of the Guidance for Sustainable Natural Rubber in Ho Chi Minh City, Vietnam', 3 November 2017, http://en.cccmc.org.cn/news/cccmcinformation/72549.htm (accessed 12 May 2020).
[51] PBC (2018), *Summary of the China Green Finance Development Report 2018,* http://www.gov.cn/xinwen/2019-11/20/5453843/files/b61d608674b04494b3ae1aef76dd7b13.pdf (accessed 30 May 2020).

carbon pricing, may help in this regard.[52] Efforts to address life-cycle emissions and the impacts of China's green sectors and their mineral inputs will be crucial to ensuring that emissions and other environmental impacts are not simply outsourced along China's supply chains.

Engagement with the concept of green supply chains may also help address the mining sector's forest impacts. Since the 2000s, Chinese research and policy dialogues have expanded their focus from green production and procurement within government, to green public production and consumption, and most recently to green life cycles and supply chains. The China Council for International Cooperation on Environment and Development (CCICED) began exploring the use of green supply chains almost a decade ago, and the report of its taskforce on China's role in greening supply chains in 2016 cited evidence of pollution from Chinese-operated copper mines in Peru and Myanmar causing severe environmental and social impacts. It noted that such impacts can undermine the social licence of companies to operate and can damage China's reputation as a trade and investment partner. It recommended greater engagement with international guidelines for sustainability in the mining sector, the development of incentives for compliance with standards such as those of the CCCMC, and the scaling up of recycling to reduce primary demand.[53] The CCICED's attention has now turned to zero-deforestation supply chains, including those for beef, soy, palm oil, and pulp and paper. The consideration of mineral supply chains by the CCICED and other advisory bodies could raise the profile of mining's forest impacts, and encourage the development of green mineral supply chains.

Source: Based on Chatham House research and stakeholder engagement with government, international organizations and NGOs in Beijing in late 2019.

Figure 3: Global metals and minerals trade, by value, 2018



Source: Chatham House/UN Comtrade (2020), www.resourcetrade.earth.
Note: The map shows all metals and minerals trade flows over $15 billion in 2018. The inset figure shows global metals and minerals trade between 2000 and 2018, by total value traded.

[52] China Development Bank and UN Development Programme China (2019), *Harmonizing Investment and Finance Standards towards Sustainable Development along the Belt And Road,* http://www.un.org.cn/uploads/20191108/bbb5cee285b9e35d7de574f4e9e4f6df.pdf (accessed 14 May 2020).
[53] See China Council for International Cooperation on Environment and Development (CCICED) (2016), *China's Role in Greening Global Value Chains*, CCICED Special Policy Study Report, CCICED 2016 annual general meeting, 6–7 December 2016, http://www.cciced.net/cciceden/POLICY/rr/prr/2016/201612/P020161214521503400553.pdf (accessed 12 May 2020).

Deforestation-free supply chains

Greater awareness of the forest risks associated with certain minerals and producer countries could incentivize commitments to deforestation-free mineral supply chains. Consumer concerns about the environmental and social impacts of mineral supply chains have already driven supply chain and market reforms, the best known of which relate to conflict and child labour. These include the US Dodd-Frank Act, the EU Conflict Minerals Regulation and the CCCMC's Due Diligence Guidelines. The European Commission has now committed to developing legislation that will introduce mandatory human rights and environmental due diligence for companies across all sectors. At the same time, there are numerous commodity- and issue-specific standards and initiatives, from Responsible Steel to the Global Battery Alliance. Concern among consumer companies about the supply chain risks associated with cobalt from the DRC prompted the London Metal Exchange (LME) to develop its Responsible Sourcing Policy.[54] The LME is now planning to launch a platform to trade low-carbon aluminium, in response to growing consumer concerns about the climate impact of metals.[55] Apple, for example, is moving towards 100 per cent recycled products and has committed to becoming carbon neutral by 2030, including its scope 3 footprint through supply chains, which will necessitate working with suppliers.[56] Apple has already supported a joint venture between Alcoa and Rio Tinto to produce the world's first carbon-free aluminium.[57]

> Many of the supporting conditions required for forest-smart mining and supply chains will also form the basis of a decarbonized and more sustainable mining sector.

Moving beyond single-issue standards and towards more integrated standards can help. Many of the supporting conditions required for forest-smart mining and supply chains will also form the basis of a decarbonized and more sustainable mining sector. These conditions range from comprehensive, comparable emissions reporting and the expansion of carbon pricing to the development of 'green' metals products and clear signals of demand for them from consumers and investors. Direct and indirect forest impacts and their emissions implications are among several variables – including life-cycle energy, carbon and water intensity, for instance – that will need to be incorporated in supply chain standards and market mechanisms if the full cost of mining and metals production is to be accounted for. The development of credible responses here, and in turn of demand and price signals, would build a clear strategic and commercial case for producer countries and companies to ensure that they develop the most sustainable and low-carbon mining sector possible.

Raising the profile of forest-risk mineral supply chains – and making this information publicly available – may encourage consumers, investors and civil society to call upon governments and companies to support more sustainable mining practices and the development of low-carbon,

[54] LME (2019), 'LME sets out responsible sourcing requirements', press release, 25 October 2019, https://www.lme.com/News/Press-room/Press-releases/Press-releases/2019/10/LME-sets-out-responsible-sourcing-requirements (accessed 12 May 2020).
[55] Sanderson, H. (2020), 'London Metal Exchange plans 'low-carbon' aluminium trading', *Financial Times*, 5 June 2020, https://www.ft.com/content/e11cdc46-fda3-445d-a323-69e4f9c6012b (accessed 5 Jun. 2020).
[56] Apple (2020), 'Apple commits to be 100 percent carbon neutral for its supply chain and products by 2030', press release, 21 July 2020, https://www.apple.com/uk/newsroom/2020/07/apple-commits-to-be-100-percent-carbon-neutral-for-its-supply-chain-and-products-by-2030/ (accessed 31 Jul. 2020).
[57] Apple has pledged to end reliance on mining and make all products from recycled or renewable materials, and has supported the development of zero-carbon aluminium. See Nellis, S. (2019), 'Apple buys first-ever carbon-free aluminium from Alcoa-Rio Tinto venture', Reuters, 5 December 2019, https://uk.reuters.com/article/uk-apple-aluminum/apple-buys-first-ever-carbon-free-aluminium-from-alcoa-rio-tinto-venture-idUKKBN1Y91RH (accessed 1 May 2020).

low-impact metals and minerals supply chains. Better understanding of the trade-offs associated with mining in forest landscapes is crucial to informed decision-making. These trade-offs will depend on a range of factors, from the types of minerals to be produced (and whether these are critical inputs for clean technologies or more widely available/substitutable commodities) to the types of forest affected (particularly where tropical forests with great significance for emissions mitigation, ecosystem services and sustainable livelihoods are concerned). Where particularly vulnerable areas are identified, the establishment of 'no go' zones may be the only appropriate response. While the next steps will ultimately be a sovereign decision, clear signals from investors and consumers, particularly in the major consumer markets of the OECD and China, could encourage responsible decision-making.

5. Conclusion

Delivering on the long-term aims of the Paris Agreement will require an urgent halt to deforestation and support for reforestation and afforestation at scale. It will also require the development of secure and green mineral supply chains for clean technologies and sustainable infrastructure. Even where mining is not the primary driver of deforestation, its indirect and cumulative impacts can be significant, particularly in hotspots for forest risk and mining activity such as the Amazon, West Africa, the Congo Basin and Southeast Asia. With the anticipated growth in demand for some of the mineral commodities – such as iron ore, copper, nickel, gold, bauxite and cobalt – that are frequently mined in forest landscapes, there is a growing risk of mining-induced deforestation and forest degradation. While investors and consumers have long been aware of forest-risk agricultural commodities, other economic drivers of deforestation – including mining and its associated infrastructure – remain underexplored.

> In some cases, forest-smart approaches are available, but their implementation is undermined by a lack of early and integrated planning, low levels of capacity, and limited access to finance. In other cases, particularly where critical forests are at risk, the only forest-smart approach will be not to mine at all.

This paper has set out the current state of knowledge on the mining's impacts on forests, and the potential for forest-smart approaches to help mitigate them. In some cases, forest-smart approaches are available, but their implementation is undermined by a lack of early and integrated planning, low levels of capacity, and limited access to finance. In other cases, particularly where critical forests are at risk, the only forest-smart approach will be not to mine at all. This paper has also highlighted areas for further research and engagement, which could help inform the development of enabling finance mechanisms and forest monitoring systems, and the implementation of forest-smart approaches at country, company and sector level. In the first instance, better-integrated approaches to the monitoring and disclosure of the mining sector's forest impacts – including their associated emissions and biodiversity impacts – can raise awareness and support effective investor, consumer and civil society engagement.

Abbreviations and Acronyms

BRI	Belt and Road Initiative
CBRC	China Banking Regulatory Commission
CCCMC	China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters
CCICED	China Council for International Cooperation on Environment and Development
COMET	Coalition on Materials Emissions Transparency
CSBI	Cross-Sector Biodiversity Initiative
DRC	Democratic Republic of the Congo
ESG	environmental, social and governance
ESIA	environmental and social impact assessment
F4F	Finance 4 Forests
FCPF	Forest Carbon Partnership Facility
FREL	forest reference emission level
FRL	forest reference level
GHG	greenhouse gas
IETA	International Emissions Trading Association
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
ITMO	internationally transferred mitigation obligation
LME	London Metal Exchange
MDB	multilateral development bank
MRV	measurement, reporting and verification
NDC	Nationally Determined Contribution
NGO	non-governmental organization
NYDF	New York Declaration on Forests
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
PBC	People's Bank of China
REDD+	reducing emissions from deforestation and forest degradation
SBTI	Science Based Targets initiative
SDG	Sustainable Development Goal
SIS	safeguards information system
SOE	state-owned enterprise
TCFD	Task Force on Climate-related Financial Disclosures
UNFCCC	United Nations Framework Convention on Climate Change
VCU	verified carbon unit

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Cover image: Satellite image of the Carajás iron ore mine – the world's largest – in northern Brazil, 20 July 2017.

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