Centre for Social Responsibility in Mining
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# CSRM Occasional Paper: ESG and the Future of Copper

# Editors

Prof. John Owen, Deputy Director, CSRM
Prof. Deanna Kemp, Director, CSRM
Prof. Rick Valenta, Director, BRC
Dr Eleonore Lebre, Research Fellow, CSRM

Centre for Social Responsibility in Mining (CSRM) and the Bryan Research Centre (BRC)
Sustainable Minerals Institute (SMI)
The University of Queensland, Australia

# CSRM contributors

(Alphabetical order)

Dr John Burton, Principal Research Fellow
Camille Freeman, Research Analyst
Dr Anthony Kung, Senior Research Fellow
Dr Vigya Sharma, Senior Research Fellow
Dr Kathryn Sturman, Senior Research Fellow
Dr Kamila Svobodova, Research Fellow

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# Key terms

“ESG” is an acronym for “Environmental, Social, and Governance”, and is used throughout this paper.

# The University of Queensland

Ranked in the world's top 50[1], The University of Queensland (UQ) is one of Australia's leading research and teaching institutions. UQ strives for excellence through the creation, preservation, transfer and application of knowledge. For more than a century, we have educated and worked with outstanding people to deliver knowledge leadership for a better world.

# Sustainable Minerals Institute

The Sustainable Minerals Institute (SMI) is a world-leading research institute committed to developing knowledge-based solutions to the sustainability challenges of the global resource industry, and to training the next generation of industry and community leaders. The Institute is transdisciplinary, and our work is impartial and rigorous. Our research integrates the expertise of production, environmental and social science specialists to deliver responsible resource development.

# Centre for Social Responsibility in Mining

The Centre for Social Responsibility in Mining (CSRM) focuses on the social, cultural, economic, and political challenges that occur when change is brought about by mineral and metal extraction. The Centre contributes to industry change through independent research, teaching and by convening multi-stakeholder dialogue processes. Our team consists of geographers, anthropologists, sociologists, political scientists, economists, development, and natural resource specialists.

[1] QS World University Rankings and Performance Ranking of Scientific Papers for World Universities, 2018.

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# 1. Introduction and overview

In April 2021, the Centre for Social Responsibility in Mining (CSRM) undertook to develop an issues paper identifying long-term risks, issues, and trends for copper – focusing on environmental, social, and governance (ESG) considerations.

The paper begins with a broad scan of global issues and trends followed by issues specific to copper. The final section offers reflections for the industry as it thinks its way through these complex matters. Table 1 describes each section. The paper has been prepared through desktop research and a targeted review of grey and academic literature.[2] Informal discussions with five subject matter experts have been incorporated throughout the sections of the paper.

[2] Grey literature includes publicly available reports, papers, and information from credible institutions and organisations.

**Table 1: Structure of the paper**

| Section | Content |
|---|---|
| 1. Introduction and overview | Provides context to the assignment and explains the content and ordering of information across the sections. |
| 2. ESG trends and mining: a snapshot of global issues | Presents a snapshot overview of key global trends, and implications for mining. |
| 3. ESG and the future of copper | Presents a selection of key ESG-related trends in the global copper market. |
| 4. Reflections for the industry | Offers a series of high-level reflections on key issues and take-aways for the industry into the future. |

# 2. ESG trends: a snapshot of global issues

With literally hundreds of risks, issues, and trends that could have been included in the initial scan, CSRM selected those top 20 or so megatrends, current and emerging, with the greatest relevance to mining, and for which reliable data from reputable sources was available.[3] The issues have been organised under three main headings: environment and climate, markets and industry, and people and rights.

## 2.1 Environment and Climate

### 2.1.1 Climate change

Climate change is widely described as humanity's most pressing challenge. Over the past decade, climate-induced disasters have hit key mining jurisdictions such as Mozambique, Madagascar, Zimbabwe, and the Philippines.[4] More than 1 billion people live in countries with high exposure to climate-related hazards and limited capacity to recover when a disaster occurs.[5] According to a recent International Energy Agency report, current global commitments to lower carbon emissions will not be enough to keep global warming under 2.0°C.[6] For miners, this means that operations will have to adapt to changing climate conditions and more frequent extreme weather events. This suggests tougher ESG conditions as the climate crisis drives impoverishment, population displacement, and conflict in the most affected regions. Climate change is driving test cases in jurisdictions where the legislative framework provides a basis for legal challenges. The Shell judgement in the Netherlands and Whitehaven coal in Australia are cases in point.[7]

[3] The number of megatrends covered was limited by the time available to complete the project, and the preferred length of a CSRM Occasional Paper.

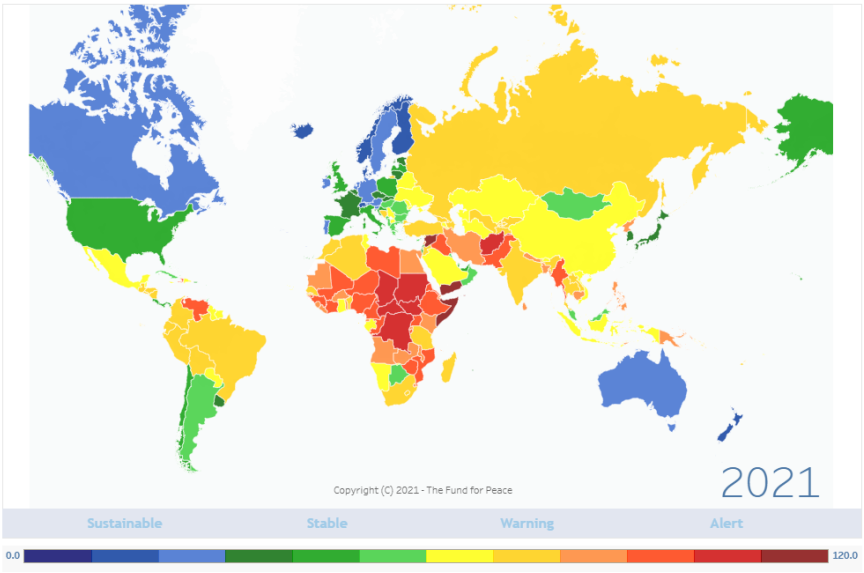
[4] Eckstein, D., Künzel, V., & Schäfer, L. (2021). *Global Climate Risk Index 2021 - Who suffers most from extreme weather events? Weather-Related loss events in 2019 and 2000-2019* (Briefing paper). German Watch. https://reliefweb.int/report/world/global-climate-risk-index-2021

[5] United Nations High Commissioner for Refugees. (2021). *Displaced on the frontlines of the climate emergency*. https://storymaps.arcgis.com/stories/065d18218b654c798ae9f360a626d903

[6] International Energy Agency. (2021). *Net Zero by 2050: A roadmap for the global energy sector*. https://www.iea.org/reports/net-zero-by-2050

[7] Schuijers, L. (2021, May 21). *In a landmark judgment, the Federal Court found the environment minister has a duty of care to young people*. The Conversation. https://theconversation.com/in-a-landmark-judgment-the-federal-court-found-the-environment-minister-has-a-duty-of-care-to-young-people-161650

*Figure 1: Fragile states index heat map*[8]




*Source: The Fund for Peace, 2021*

### 2.1.2 Water

The interaction between water and mining is complex and geographically variable. Climate change is likely to affect both water availability and quality in potentially uncertain ways.[9] Analyses of global copper, lead-zinc, and nickel resources indicate a considerable overlap between mining and regions at risk of water stress and/or changes in climate classification.[10] According to a recent McKinsey report, an estimated 80% of copper production in Chile is currently located in areas of extremely high water stress, rising to 100% by 2040.[11] In high rainfall areas, increased flood events will contribute to an already established concern about the risk of catastrophic tailings dam disasters.[12] Acid mine drainage is recognised as a global environmental problem, widely reported in every continent other than Antarctica, with consequences potentially persisting for centuries.[13,14] Mining impacts on water resources will drive tension between water users into the future. In light of these pressures, major mining jurisdictions are bolstering their water regulations,[15] while the OECD is advocating for more robust water governance amongst member states.[16]

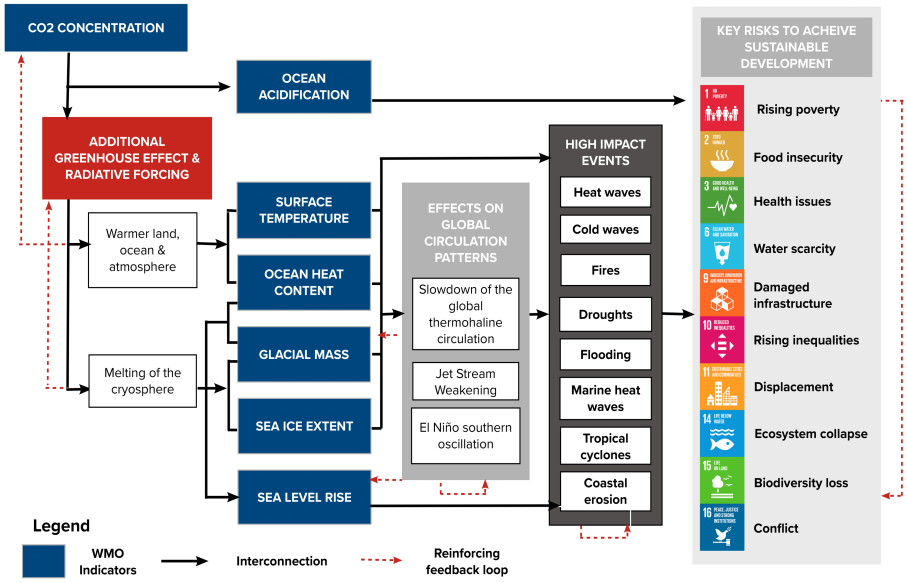
### 2.1.3 Emissions reduction (air)

In 2020, $CO_2$ emissions were predicted to fall by up to 7% due to the economic slowdown from the coronavirus pandemic. Under the 2015 Paris Agreement,[17] 195 countries pledged to limit global warming to

[8] Fund for Peace. (2021). *Fragility in the world*. https://fragilestatesindex.org/
[9] Intergovernmental Panel on Climate Change. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. https://www.ipcc.ch/report/ar5/syr/
[10] Northey, S.A., Mudd, G.M., Werner, T.T., Jowitt, S.M., Haque, N., Yellishetty, M., & Weng, Z. (2017). The exposure of global base metal resources to water criticality, scarcity and climate change. *Global Environmental Change, 44*, 109–124. https://doi.org/10.1016/j.gloenvcha.2017.04.004
[11] Delevingne, L., Glazener, W., Gregoir, L., & Henderson, K. (2020). *Climate risk and decarbonization: What every mining CEO needs to know.* McKinsey & Company. https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-decarbonization-what-every-mining-ceo-needs-to-know
[12] Schoenberger, E. (2016). Environmentally sustainable mining: The case of tailings storage facilities. *Resources Policy, 49*, 119–128. https://doi.org/10.1016/j.resourpol.2016.04.009
[13] Simate, G. S., & Ndlovu, S. (2021). *Acid mine drainage: From waste to resources* (First edition.). CRC Press/Taylor & Francis Group, LLC.
[14] Mutanga, S.S., & Mujuru, M. (Eds.). (2017). *Management and mitigation of acid mine drainage in South Africa input for mineral beneficiation in Africa*. Project Muse.
[15] Thomashausen, S., Maennling, N., & Mebratu-Tsegaye, T. (2018). A comparative overview of legal frameworks governing water use and waste water discharge in the mining sector. *Resources Policy, 55*, 143–151. https://doi.org/10.1016/j.resourpol.2017.11.012
[16] Organisation for Economic Co-operation and Development. (2021*). Toolkit for water policies and governance: Converging towards the OECD council recommendation on water*. https://www.oecd.org/environment/toolkit-for-water-policies-and-governance-ed1a7936-en.htm
[17] United Nations. (2015). *Paris Agreement*. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

well below 2.0°C by 2050. On current trends, the probability of staying below 2.0°C is 5%. To that end, we can expect increasing pressure from governments, investors, and society to set more challenging emissions reduction targets in the coming years. The mining industry is uniquely positioned in the climate mitigation landscape. It provides the raw materials needed to produce green energy. At the same time, resource projects are vulnerable to societal pressure, policy changes, and the environmental impacts of climate change, such as extreme weather events. Researchers expect to see more attention paid to the mainstreaming of green technologies in mining operations and the industry's carbon footprint.[18] Between 2017 and 2020, the global market for carbon offsets doubled, with demand projected to increase by a factor of 100 by 2050.[19] To address concerns about the quality and effectiveness of carbon offsetting practices, the Taskforce on Scaling Voluntary Carbon Markets recently announced an Independent Governance Body for monitoring and oversight.[20]

*Figure 2: Impacts and risks of rising atmospheric $CO_2$ concentrations*[21]




*Source: World Meteorological Organization, 2021*

[18] Kirk, T. & Lund, J. (2018). *Decarbonization pathways for mines. A headlamp in the darkness*. Rocky Mountain Institute. https://rmi.org/wp-content/uploads/2018/08/RMI_Decarbonization_Pathways_for_Mines_2018.pdf

[19] Blaufelder, C., Levy, C., Mannion, P., & Pinner, D. (2021, January 29). *A blueprint for scaling voluntary carbon markets to meet the climate challenge*. McKinsey. https://www.mckinsey.com/business-functions/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

[20] Institute of International Finance. (2021, July 8). *Taskforce on scaling voluntary carbon markets publishes roadmap for strengthening market integrity.* https://www.iif.com/tsvcm/Main-Page/Publications/ID/4496/Taskforce-on-Scaling-Voluntary-Carbon-Markets-Publishes-Roadmap-for-Strengthening-Market-Integrity

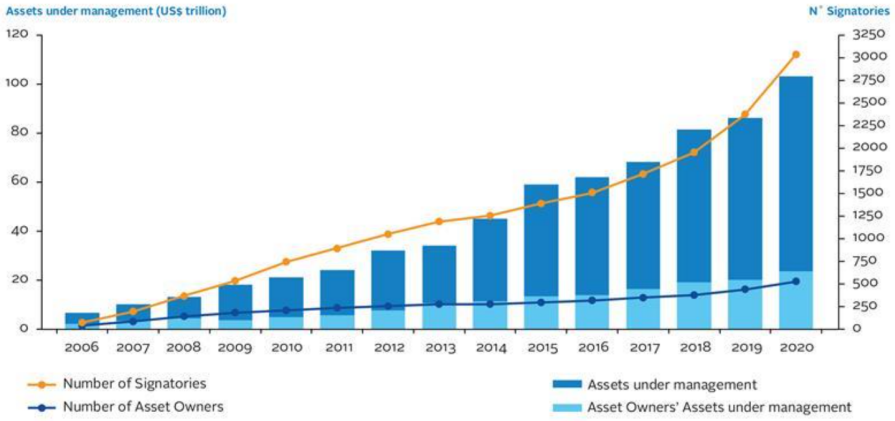
[21] World Meteorological Organization. (2021). *State of global climate 2020 (No. 1264)*. https://library.wmo.int/doc_num.php?explnum_id=10618

## 2.2 Markets and Industry

### 2.2.1 ESG and investor action

The last five years have seen a shift in the way investors view the ESG performance of companies. Whereas previously ESG policies broadly signalled a company's intent to "do good", measurable ESG performance is seen as an indicator of a company's ability to manage risk,[22] with ESG performance explicitly connected to financial performance.[23,24] Signatories to the UN Principles for Responsible Investment rose by nearly 30% in 2019–20. This includes 2,701 investors collectively managing US$103.4 trillion in assets across all sectors.[25] Attention on mining companies' ESG performance has persisted through the coronavirus pandemic;[26] KPMG's 2021 Global Mining Risk Survey places community relations, environmental risks, permitting risk, and political instability within the top ten business risks.[27] These risks have opened the way for a proliferation of industry standards to help investors better navigate the market and quickly determine those companies that are seen to be driving down these kinds of risks. In turn, this proliferation has created a new and variable compliance burden for companies. With a lack of information about implementation, whether these new standards and metrics drive performance improvements remains an open question.

*Figure 3: Number of signatories to the UN Principles for Responsible Investment (as of 31 March 2020), and the collective value of assets under management* [25]




*Source: UN-PRI, 2020*

### 2.2.2 Carbon pricing

A carbon tax is one of two key instruments used to price greenhouse gas (GHG) emissions. According to the World Bank, sixty-one (61) carbon pricing initiatives were either implemented or scheduled for implementation in 2020. These initiatives account for approximately 22% of the world's GHG emissions.[28] Despite more jurisdictions recognising the value of carbon pricing, the impact of the tax on long-term environmental outcomes is uncertain. According to the International Monetary Fund, the global average price

[22] Serafeim, G. (2020, September-October). *Social-impact efforts that create real value*. Harvard Business Review. https://hbr.org/2020/09/social-impact-efforts-that-create-real-value

[23] Church Commissioners for England. (2021). *Responsible investment policy* (version 2.0). https://www.churchofengland.org/sites/default/files/2021-03/Responsible%20Investment%20Policy%20FINAL%20%2829_March_21%29.pdf

[24] Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment, 5*(4), 210–233. https://doi.org/10.1080/20430795.2015.1118917

[25] United Nations Principles for Responsible Investment. (2020). *Enhance our global footprint* (Annual Report 2020). https://www.unpri.org/annual-report-2020/how-we-work/building-our-effectiveness/enhance-our-global-footprint

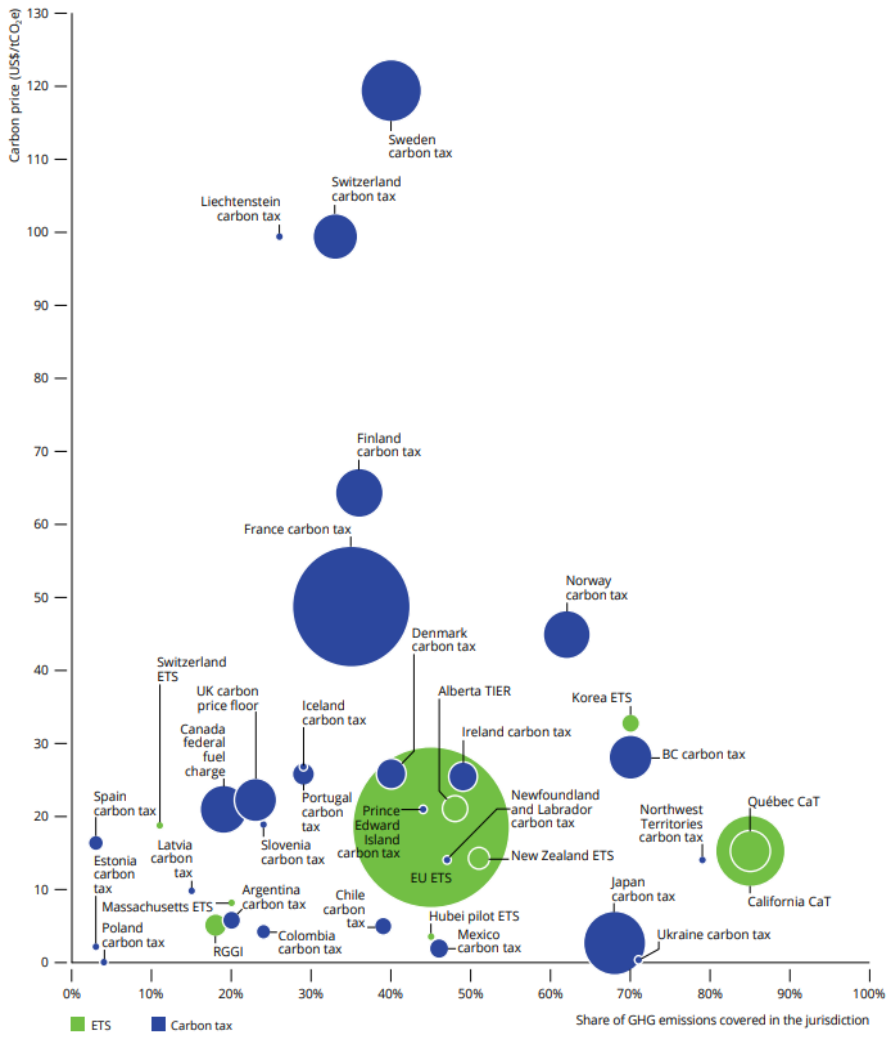
[26] Kilbey, B., Warwik, F., & Forster, H. (2020, July 13). *ESG and mining: Sustainability after coronavirus.* S&P Global. https://www.spglobal.com/en/research-insights/articles/esg-and-mining-sustainability-after-coronavirus

[27] KPMG. (2021, March 2). *Global mining risk survey report 2021*. https://home.kpmg/au/en/home/insights/2021/03/global-mining-risk-survey-report.html

[28] World Bank. (2020). *State and trends of carbon pricing 2020*. World Bank Group. https://openknowledge.worldbank.org/handle/10986/33809

for carbon is US$2/tCO2, well short of the US$50–100/tCO2 needed by 2030 to meet the goals of the Paris Agreement.[29] The private sector has been following carbon pricing initiatives closely, and many now use internal carbon pricing to reduce their carbon footprint across supply chains. With most major mining companies envisioning carbon-neutral mining by 2050, better accountability for different emission types (Scope 1, 2, and 3) will be critical to calculating the "right" price for carbon. For example, Rio Tinto's scenario planning estimates the price on carbon to range between US$60–130/tCO2 by 2050.[30]

*Figure 4: Global variation in carbon pricing initiatives* [28]




*Source: World Bank, 2020*

[29] International Monetary Fund. (2019, December). The economics of climate. *Finance and Development: IMF 56*(4), 16. https://www.imf.org/external/pubs/ft/fandd/2019/12/pdf/fd1219.pdf

[30] Rio Tinto. (2020). *Climate change report 2020*. https://www.riotinto.com/en/invest/reports/climate-change-report

### 2.2.3 Metal criticality and the energy transition

Critical metals are metals that are identified as being of strategic importance and whose future supply may be at risk. Major consumer countries each make their own assessment of criticality. Both the European Commission[31] and the U.S. government[32] recently published a list of about 30 minerals deemed critical. Of particular concern are the supply risks for some of the metals needed for the growing clean energy market, such as cobalt, primarily mined in the Democratic Republic of Congo, and rare earth elements, a market heavily dominated by China. The International Energy Agency anticipates that the energy sector will become a leading consumer of lithium, cobalt, nickel, copper, and rare earths.[33] This includes the electric vehicle industry, where sales worldwide climbed 40% in 2020 to around 3 million, reaching a market share of over 4%. In this context, miners have an opportunity to position themselves as reliable suppliers of critical metals. At the same time, key minerals could be subject to further price volatility and growing geopolitical influence.

*Figure 5: Critical mineral needs for clean energy technologies* [33]

| | Copper | Cobalt | Nickel | Lithium | REEs | Chromium | Zinc | PGMs | Aluminium* |
|---|---|---|---|---|---|---|---|---|---|
| Solar PV | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● |
| Wind | ● | ○ | ◍ | ○ | ● | ◍ | ● | ○ | ◍ |
| Hydro | ◍ | ○ | ○ | ○ | ○ | ◍ | ◍ | ○ | ◍ |
| CSP | ◍ | ○ | ◍ | ○ | ○ | ● | ◍ | ○ | ● |
| Bioenergy | ● | ○ | ○ | ○ | ○ | ○ | ◍ | ○ | ◍ |
| Geothermal | ○ | ○ | ● | ○ | ○ | ● | ○ | ○ | ○ |
| Nuclear | ◍ | ○ | ◍ | ○ | ○ | ◍ | ○ | ○ | ○ |
| Electricity networks | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● |
| EVs and battery storage | ● | ● | ● | ● | ● | ○ | ○ | ○ | ● |
| Hydrogen | ○ | ○ | ● | ○ | ◍ | ○ | ○ | ● | ◍ |

Notes: Shading indicates the relative importance of minerals for a particular clean energy technology (● = high; ◍ = moderate; ○ = low), which are discussed in their respective sections in this chapter. CSP = concentrating solar power; PGM = platinum group metals.
* In this report, aluminium demand is assessed for electricity networks only and is not included in the aggregate demand projections.

*Source: International Energy Agency, 2021*

### 2.2.4 Technology and innovation

The OECD considers innovation as a key "enabler" that decouples growth from resource depletion.[34] Released in May 2021, the International Energy Agency's roadmap for Net-Zero by 2050 identifies innovation as the central piece in the energy transition puzzle.[35] Artificial intelligence, big data analytics, automation, and collaborative robotics are regarded as the defining trends for the coming three decades.[36] Future decisions about resource optimisation, security, and overall productivity will rely heavily on a number of these technologies.[37] The energy and extractives sector is at the forefront of this rapidly changing technological landscape. Scarcity of minerals, such as cobalt, is already pushing scientists to innovate and

[31] Communication from the Commission to the European Parliament, the Council, and the European Economic and Social Committee and the Committee of the regions [Communications-COM]. (2020). *Critical raw materials resilience: Charting a path towards greater security and sustainability* (COM-474 final). European Commission. https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX:52020DC0474

[32] United States Geological Survey. (2018, May 18). *Interior releases 2018's final list of 35 minerals deemed critical to U.S. national security and the economy.* https://www.usgs.gov/news/interior-releases-2018-s-final-list-35-minerals-deemed-critical-us-national-security-and

[33] International Energy Agency. (2021). *The role of critical minerals in clean energy transitions* (World Energy Outlook Special Report). https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

[34] Organisation for Economic Co-operation and Development. (2015). *The innovation imperative: Contributing to productivity, growth and well-being.* OECD Publishing. http://dx.doi.org/10.1787/9789264239814-en

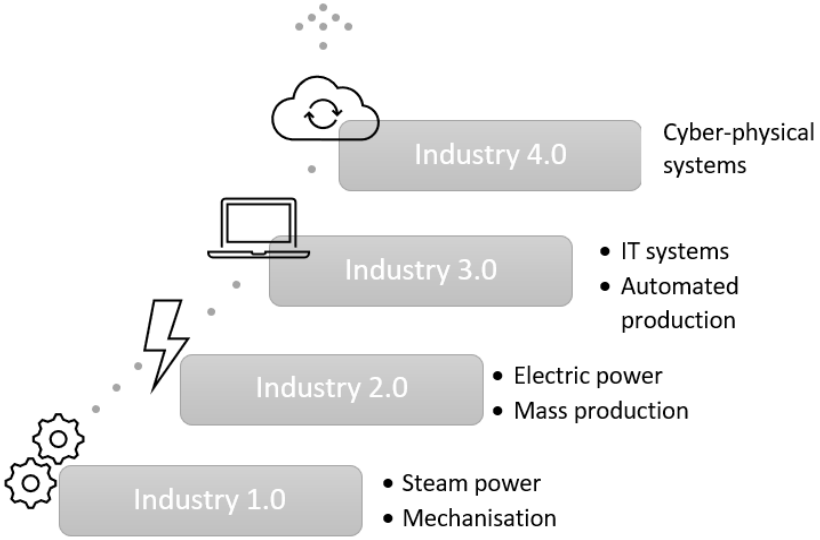
[35] International Energy Agency. (2021). Net zero by 2050: A roadmap for the global energy sector. IEA Flagship Report. https://www.iea.org/reports/net-zero-by-2050

[36] Sánchez, F., & Hartlieb, P. (2020). Innovation in the mining industry: Technological trends and a case study of the challenges of disruptive innovation. *Mining, Metallurgy & Exploration, 37*, 1385–1399. https://doi.org/10.1007/s42461-020-00262-1

[37] Schatsky, D. (2020). Uncertainty and innovation at speed: How digital maturity can boost the ability to innovate. Deloitte. https://www2.deloitte.com/global/en/insights/focus/signals-for-strategists/digital-business-transformation-innovation-efforts.html

find suitable replacements.[38] The introduction of some of these technologies may raise other challenges, such as artificial intelligence and automation in the face of rising global unemployment.[39] The next few decades are an opportunity for the industry to lead by example: to show how to balance the economics of emerging technological possibilities with commitments to people and the planet.

*Figure 6: The fourth wave of Industrial Innovation*[40]



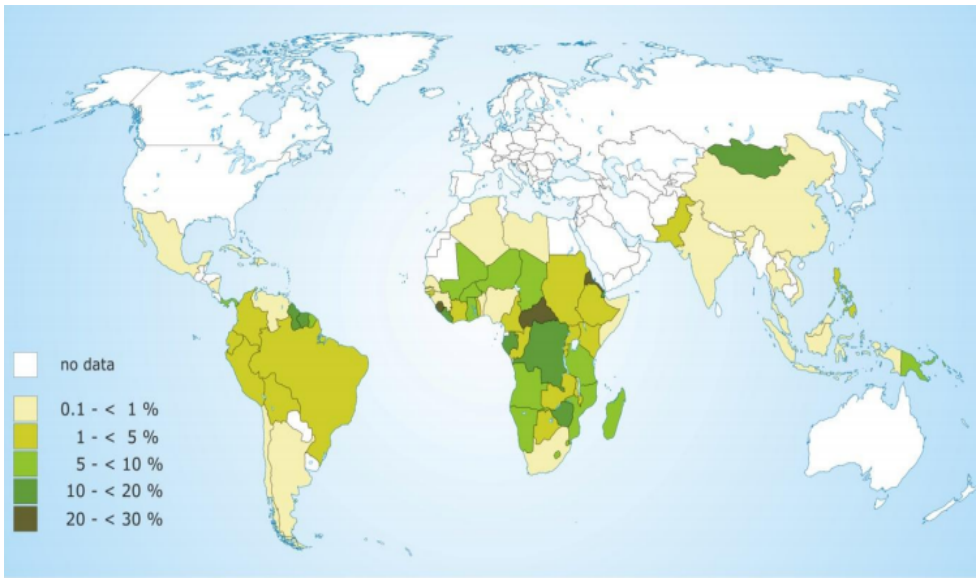

*Source: Adapted from Sánchez and Hartlieb, 2020*

### 2.2.5 The LSM-ASM interface

The operation of large-scale mining (LSM) and artisanal and small-scale mining (ASM) within a shared physical environment presents a complex dynamic. Environmental impacts, health hazards, and safety aspects are concerns in LSM and ASM. The cumulative downstream effects of both sectors operating in close proximity can be significant. In 1999, the International Labour Organisation estimated that up to 100 million people depended on small scale mining for their livelihoods, roughly the same number as the large-scale sector.[41] According to the International Institute for Sustainable Development, these numbers have risen sharply, with 150 million people from across 80 countries depending on ASM in 2018.[42] The IISD estimates that 50% of the ASM workforce in Africa are women. Historically, the focus of policy makers, including the World Bank and the International Finance Corporation, has centred on cases where ASM are competing with LSM over access to gold. Access to capital and improved technologies are seeing higher levels of mechanisation and competition between ASM and the large-scale sector, particularly as markets for cobalt, nickel, and copper heat up. In addition to 20% of the global supply of gold, currently, 26% of global tantalum production and 25% of global tin production come from ASM. The question of "legality" continues to complicate engagement between the two sectors. LSM companies are committing to work with legal ASM, but ASM is deemed "illegal" by the state in most jurisdictions.

[38] CSIRO. (2021). *Securing the mineral supply for batteries of the future* (Issue 23). https://www.csiro.au/en/work-with-us/industries/mining-resources/Resourceful-magazine/Issue-23/Securing-the-mineral-supply-for-batteries
[39] Organisation for Economic Co-operation and Development. (2021). *Unemployment rate*. https://data.oecd.org/unemp/unemployment-rate.htm
[40] Sánchez, F., & Hartlieb, P. (2020). Innovation in the mining industry: Technological trends and a case study of the challenges of disruptive innovation. *Mining, Metallurgy & Exploration, 37*, 1385–1399. https://doi.org/10.1007/s42461-020-00262-1
[41] International Labour Organisation. (1991). *Social and labour issues in small-scale mines. Report for discussion at the Tripartite Meeting on social and labour issues in small-scale Mines*. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_714371.pdf
[42] International Institute for Sustainable Development. (2018). *Global trends in artisanal and small-scale mining (ASM): A review of key numbers and issues*. https://www.iisd.org/system/files/publications/igf-asm-global-trends.pdf

*Figure 7: Percentage of the population that depends on ASM*[43]




*Source: Dorner et al., 2012*

### 2.2.6 Trends in mineral supply chains

Geopolitical tensions are a source of both opportunity and threat to mineral producing countries and mining companies as they continue to disrupt mineral supply chains. The major risk in this context is the concentration of certain minerals from just a few governance-challenged countries. For example, 59% of cobalt is currently mined in the Democratic Republic of Congo, 44% of lithium in Chile, and 71% of platinum in South Africa, while China produces most of the rare earth minerals.[44]

China's rising economic and political power has seen an increased demand for all minerals and metals, but also trade restrictions for coal and rare earth minerals.[45] China's dominance is not guaranteed, with Goldman Sachs indicating that it no longer saw China as the absolute centre of commodities pricing, reasoning that the pace of demand recovery in developed markets will see China crowded out by Western consumers.[46] Onshore beneficiation is a continuing risk to foreign mining investment in South East Asia, Africa, and Latin America.[47] At the same time, the race is on for resource-rich countries to explore, develop, and produce a more secure supply of critical minerals and metals.[48]

### 2.2.7 Trends in traceability and chain of custody

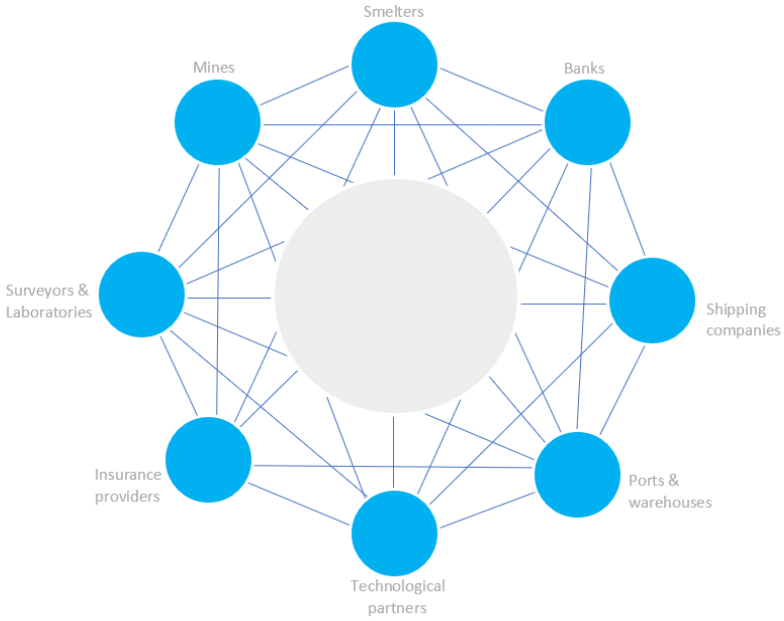
Regulators in North America, the EU, and the OECD hold mineral suppliers to ever more exacting environmental, social, and governance standards, expanding from issues of conflict to child labour, modern slavery, climate, and biodiversity.[49] Firm-to-firm responsible sourcing of minerals from one end of the supply chain to the other is a growing trend. One example between multinational enterprises is the bespoke supply

[43] Dorner, U., Franken, G., Liedtke, M. & Sievers, H. (2012). *Artisanal and small-scale mining (ASM)* (Working Paper 19). Polinares. http://pratclif.com/2015/mines-ressources/ polinares/chapter7.pdf
[44] EU Science Hub (2021, May 28). *Raw material information system (RMIS)*. European Commission. https://rmis.jrc.ec.europa.eu/
[45] Maennling, N., & Teledano, P. (2019, March, 20). *Seven trends that will shape the future of mining and metals*. World Economic Forum. https://www.weforum.org/agenda/2019/03/seven-trends-shaping-the-future-of-the-mining-and-metals-sector/
[46] Reuters. (2021, May 28). *Goldman says China is no longer center of commodities pricing*. https://www.reuters.com/article/us-commodities-research-goldman-idUSKCN2D90IM
[47] Korinek, J. (2018, July 23). Trade restrictions on metals and minerals. Resource Trade.Earth. https://resourcetrade.earth/publications/trade-restrictions-on-metals-and-minerals
[48] Department of Industry, Science, Energy and Resources. (2019). *Australia's Critical Minerals Strategy 2019*. Australian Government. https://www.industry.gov.au/data-and-publications/australias-critical-minerals-strategy
[49] Organisation for Economic Co-operation and Development. (2021). *Trends in stakeholder reporting: Mineral supply chains.* http://mneguidelines.oecd.org/trendsinstakeholderreportingmineralsupplychains.htm

contract for “single-origin” bauxite from Gove, Australia, through Rio Tinto’s alumina refining and aluminium production for Nespresso’s coffee pods.[50]

The big brand names in electronics, cars, and jewellery are similarly teaming up with major mining companies to support chain of custody standards and certification schemes for specific metals and minerals.[51] New technology and approaches are improving traceability and chain of custody. For example, blockchain technology enables end-to-end tracking of ores and concentrates via the secure exchange of trade data.[52] Different approaches have been developed to specific metals, gemstones, and other minerals, such as identity preservation, mass balance, or segregation of certified batches.[53]

*Figure 8: Blockchain solutions* [52]




*Source: Weiland, 2018*

### 2.2.8 Cyber security

According to Ernst and Young, cybersecurity is the biggest threat to the global economy over the coming decade.[54] Security providers McAfee and Symantec, estimate that cybercrime will result in a loss of $90 trillion in net economic impact by 2030.[55] These projections follow steep increases in mobile ransomware and attacks on global supply chains in recent years. At the end of 2018, approximately half of the world’s population was connected to the internet in some form. This is expected to rise to 70% by 2023. In 2020–2021, major security breaches were recorded against critical civil infrastructure, including water supply,

[50] National Resources Review. (2018, November 20). *Rio Tinto to supply sustainable aluminium for coffee capsules*. https://www.nationalresourcesreview.com.au/news_article/rio-tinto-to-supply-responsibly-sourced-aluminium-for-nespresso-coffee-pods/

[51] An example is Rio Tinto’s STaRT label for aluminium that uses blockchain technology. https://www.riotinto.com/en/news/releases/2021/Rio-Tinto-launches-START-the-first-sustainability-label-for-aluminium-using-blockchain-technology

[52] Weiland, M. (2018, July 10). *Four ways blockchain will transform the mining and metals industry*. World Economic Forum. https://www.weforum.org/agenda/2018/07/4-ways-blockchain-will-transform-the-mining-and-metals-industry

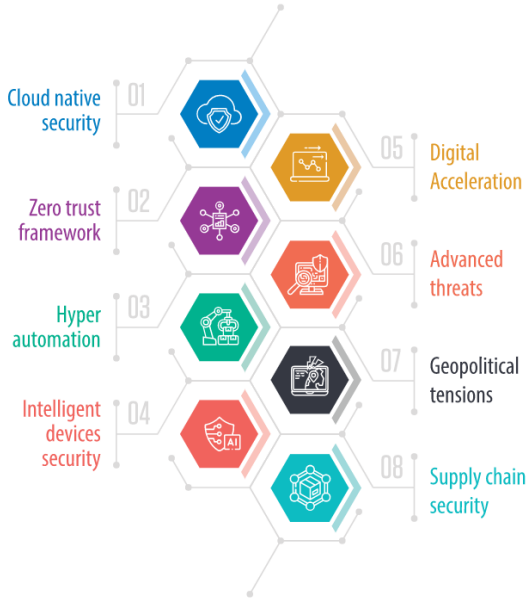
[53] ISEAL Alliance. (2016). *Chain of custody models and definitions (Version 1.0)*. https://www.isealalliance.org/get-involved/resources/iseal-guidance-chain-custody-models-and-definitions

[54] Ernst and Young. (2019). *EY CEO Imperative study 2019*. https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/growth/ey-ceo-imperative-exec-summ-single-spread-final.pdf

[55] International Telecommunication Union [ITU]. (2019). *Global Cybersecurity Index 2018*. https://www.itu.int/dms_pub/itu-d/opb/str/D-STR-GCI.01-2018-PDF-E.pdf

hospitals, and gas pipelines.[56] The world's largest meat company, JBS, fell victim to a ransomware attack in May 2021, paying $11m in crypto-currency after four days of negotiations with hackers.[57] Governments and large corporations are increasingly cited as targets of ransomware, espionage, and transparency campaigns. For the mining industry, this poses at least three risks. First, a deepening dependency on operations technology increases the avenues for potentially crippling cyber-attacks across the sector. Second, employee and other confidential information could become attractive targets for cyber-criminals. Third, accessing goods and services through a supply chain with similar technical vulnerabilities could significantly widen the industry's cyber security "front".

*Figure 9: Cybersecurity trends*[58]




*Source: Infosys, 2021*

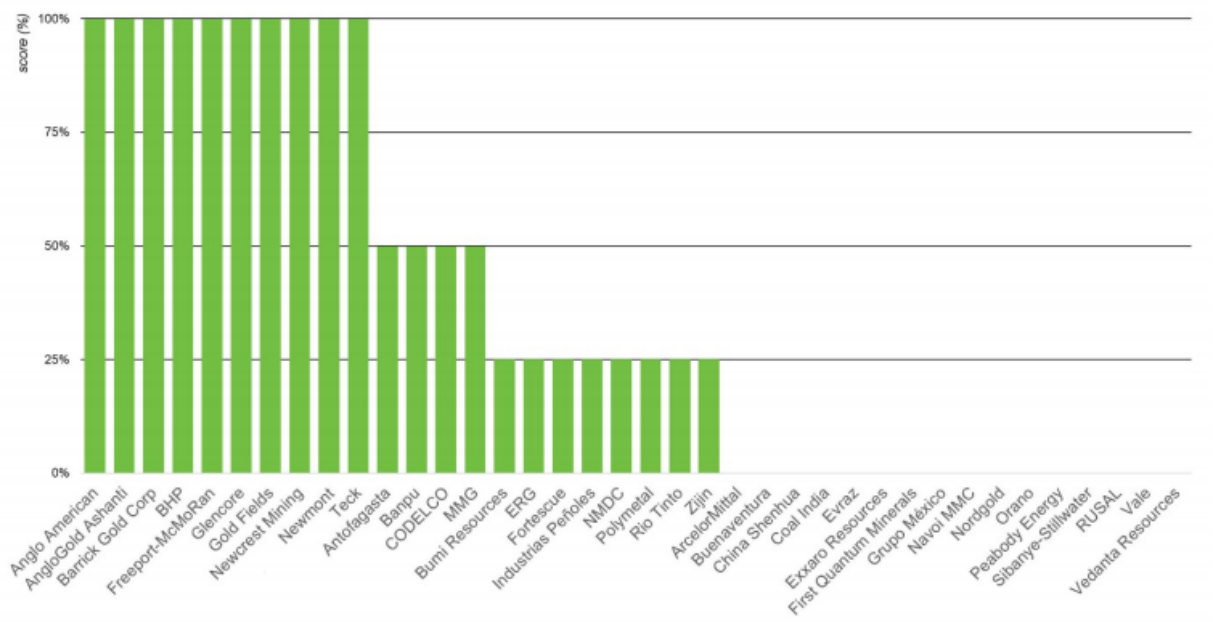
### 2.2.9 Mining incidents

Major mining incidents are a regular occurrence. In 2011, an explosion at New Zealand's Pike River mine killed 29 miners whose bodies have never been recovered.[59] According to the International Labour Organisation (ILO), while mining employs around 1% of the global labour force, it generates 8% of fatal accidents.[60] In 2014, the collapse of a tailings dam at the Mount Polley mine in Canada released 24 million cubic meters of mine waste into local pristine waterways, resulting in devastating environmental and social impacts. In 2015, the Mariana dam disaster in Brazil killed 19 people and released 43.7 million cubic metres of mine tailings polluting 650 kilometres of the Doce River.[61] Four years later, Brazil experienced another disaster, one of the worst in recorded history. In 2019, the Brumadinho dam failure killed 270 people and released 12 million cubic meters of tailings. Live footage of the incident was captured in real-time, shared on social media, and headlined global news. Over the past 60 years, there have been at least 138 major tailings

[56] Sophos. (2021). *Sophos 2021 threat report: Navigating cybersecurity in an uncertain world.* https://www.sophos.com/en-us/medialibrary/pdfs/technical-papers/sophos-2021-threat-report.pdf
[57] Bunge, J., & Newman, J. (2021, June 11). *Ransomware attack roiled meat giant JBS, then spilled over to farmers and restaurants*. The Wall Street Journal. https://www.wsj.com/articles/ransomware-attack-roiled-meat-giant-jbs-then-spilled-over-to-farmers-and-restaurants-11623403800
[58] Infosys. (2021). *2021 Cybersecurity trends report*. https://www.infosys.com/about/knowledge-institute/documents/2021-cybersecurity-trends-report.pdf
[59] British Broadcasting Corporation. (2020, November 19). *Pike River: The 29 coal miners who never came home*. https://www.bbc.com/news/world-asia-54956219
[60] International Labour Organization- STAT. (2020, April 30). *Covid-19 and the new meaning of safety and health at work*. https://ilostat.ilo.org/topics/safety-and-health-at-work/
[61] United Nations Environment Programme. (2017, November 13). *New report urges global action on mining pollution*. https://www.unep.org/news-and-stories/story/new-report-urges-global-action-mining-pollution?platform=hootsuite

dam failures, and the frequency of these events has been increasing since 1990.[62] In 2020, two ancient and sacred caves in the Juukan Gorge of Western Australia were destroyed to expand an iron ore mine. In 2015, the WWF estimated that globally almost one-third of all World Heritage Sites were under threat of oil, gas, and mining exploration.[63] A recent evidence-based assessment of 38 large-scale mining companies' policies and practices found that only 10 of the 38 companies have made public commitments to not explore or mine in World Heritage Sites and respect other protected areas.[64] Major mining incidents, and longstanding mining legacies, continue to drive community and regulator concern, which in turn drives demand for standards that impose compliance requirements onto companies.

*Figure 10: Commitment to not explore or mine in World Heritage Sites, and to respect other protected areas* [64]




*Source: Responsible Mining Foundation, 2020*

## 2.3 People and Rights

### 2.3.1 Urbanisation

In 2019, the United Nations Department of Economic and Social Affairs (UNDESA) listed urbanisation as one of four demographic megatrends, along with population growth, ageing populations, and human migration.[65] The World Bank and UNDESA predict that by 2050, 68% of the world's population − roughly 8.4 billion inhabitants – will be concentrated in urban centres.[66,67] Asia and Africa are anticipated to have the highest urban population densities and the fastest urbanisation growth.[66] By 2030, there will be 43 megacities, a 30% increase from the 33 megacities in 2018.[65] Megacities are cities with more than 10 million inhabitants. Urbanisation drives an upward demand for minerals and metals. Between 2020 and 2035, the global demand for aluminium, copper, iron ore, nickel, and zinc is predicted to increase by an average of

[62] D'Azeredo Orlando, M.T., Galvão, E.S., Sant'Ana Cavichini, A., Gabrig, C.V.T.R., Orlando, C.G.P., Grilo, C.F., Jacyra, S., Oliveira, K.S.S, Sá, F., Junior, A.C., Bastos, A.C., & da Silva Quaresma, V. (2020). Tracing iron ore tailings in the marine environment: An investigation of the Fundão dam failure. Chemosphere, 257, 127184. https://doi.org/10.1016/j.chemosphere.2020.127184

[63] WWF. (2015, October 1). *Almost a third of all natural World Heritage Sites under threat of oil, gas and mining exploration*. https://wwf.panda.org/wwf_news/?253794/Almost-a-third-of-all-natural-World-HeritageSites-under-threat-of-oil-gas-and-mining-exploration

[64] Responsible Mining Foundation. (2020, June 16). *Heritage lost to mining: A collective responsibility*. https://www.responsibleminingfoundation.org/app/uploads/EN_Research-Insight_WHS-and-protected-areas_June-2020.pdf

[65] United Nations Department of Economic and Social Affairs. (2019). *World Population Prospects 2019*. https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf

[66] United Nations Department of Economic and Social Affairs. (2018). *The world's cities in 2018- Data Booklet*. United Nations. https://population.un.org/wup/Publications/

[67] World Bank. (2020, April 20). *Urban development: Overview*. https://www.worldbank.org/en/topic/urbandevelopment/overview

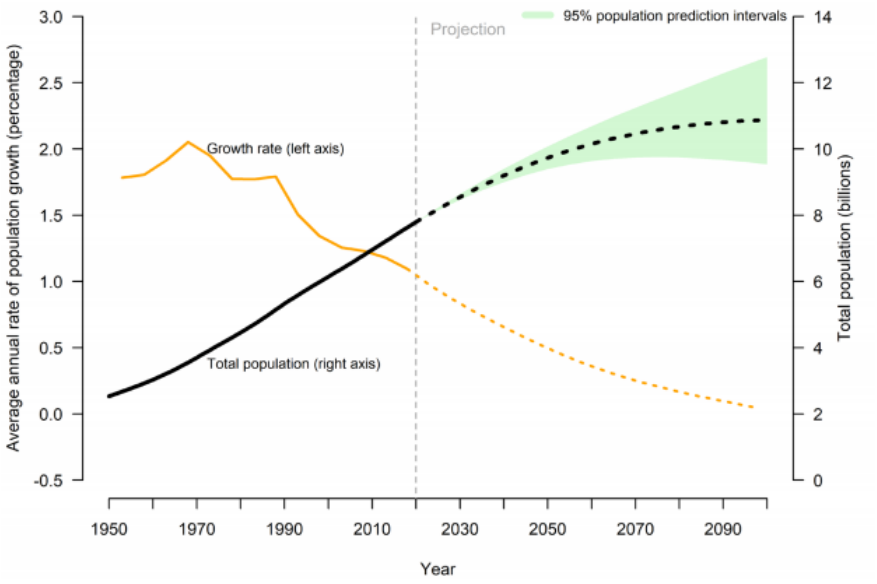
60%.[68] While urbanisation is predicted to slow in 2050,[69] impacts on land and natural resources from urban sprawl will have significant long-term effects.

*Figure 11: The ten largest cities in 2018 and 2030* [66]

| City size rank | City | Population in 2018 (thousands) | City | Population in 2030 (thousands) |
|---|---|---|---|---|
| 1 | Tokyo, Japan | 37 468 | Delhi, India | 38 939 |
| 2 | Delhi, India | 28 514 | Tokyo, Japan | 36 574 |
| 3 | Shanghai, China | 25 582 | Shanghai, China | 32 869 |
| 4 | São Paulo, Brazil | 21 650 | Dhaka, Bangladesh | 28 076 |
| 5 | Ciudad de México (Mexico City), Mexico | 21 581 | Al-Qahirah (Cairo), Egypt | 25 517 |
| 6 | Al-Qahirah (Cairo), Egypt | 20 076 | Mumbai (Bombay), India | 24 572 |
| 7 | Mumbai (Bombay), India | 19 980 | Beijing, China | 24 282 |
| 8 | Beijing, China | 19 618 | Ciudad de México (Mexico City), Mexico | 24 111 |
| 9 | Dhaka, Bangladesh | 19 578 | São Paulo, Brazil | 23 824 |
| 10 | Kinki M.M.A. (Osaka), Japan | 19 281 | Kinshasa, Democratic Republic of the Congo | 21 914 |

*Source: UNDEAS, 2018*

*Figure 12: Population size and annual growth rate for the world* [65]




*Source: UNDEAS, 2019*

## 2.3.2 Pandemics

Pandemics are defined as a global outbreak that exceeds the normal rates of infection and mortality levels for a disease. By June 2021, the coronavirus pandemic had claimed 3,727,605 lives globally. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Bureau and Multidisciplinary Expert Panel (MEP) estimates that there are 1.7 million undiscovered viruses existing in mammal and avian hosts, of which 631,000 to 827,000 could infect humans.[70] MEP predicts that without a "seismic shift" in the way countries manage infectious disease, pandemics will become more frequent,

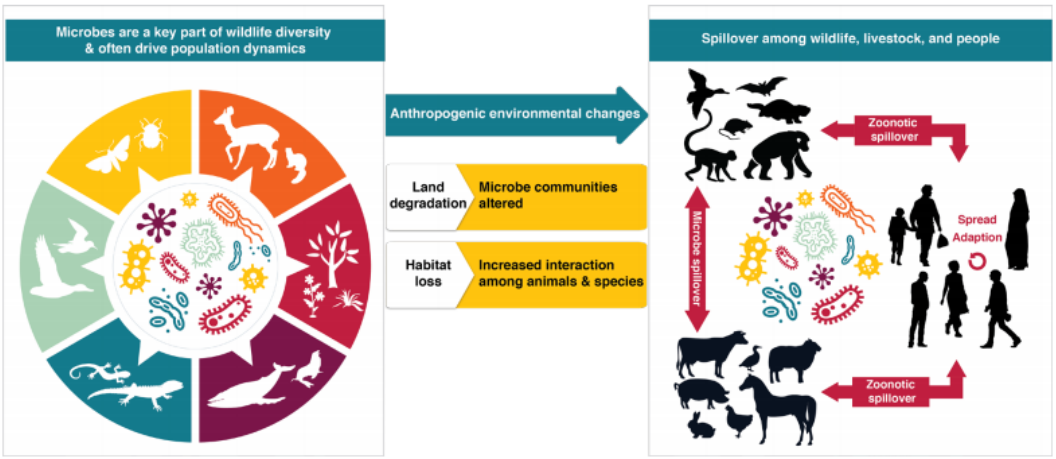
[68] Swann Group (2020). *Metal megatrends: Where will we be in 2035?* https://the-swann-group.com/wp-content/uploads/2020/11/MegaTrends2035.pdf

[69] United Nations Department of Economic and Social Affairs. (2018). *World urbanization prospects: The 2018 revision- key insights*. https://population.un.org/wup/

[70] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2020). *Workshop report on biodiversity and pandemics*. https://www.ipbes.net/pandemics

spread faster, and kill more people than Covid-19.[71] As a response, in 2021, the World Health Organisation (WHO) established a Pandemic and Epidemic Intelligence Hub to predict, prevent, detect, prepare for, and respond to, worldwide health threats.[72] Along with prevention, there is an urgent need to develop, scale up, and make vaccines widely available.[73] According to a recent estimate by the International Monetary Fund (IMF), the coronavirus pandemic has cost the world economy approximately US$22 trillion.[74] If pandemics become the norm, the cost of doing business is likely to increase drastically with prolonged restrictions around the movement of material, people, and capital.

*Figure 13: The origins and drivers of emerging zoonotic diseases and pandemics* [56]



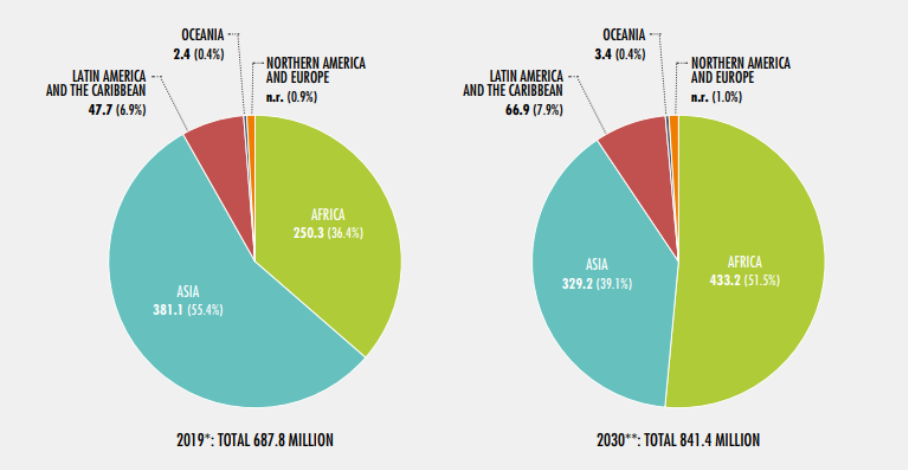

*Source: IPBES, 2020*

### 2.3.3 Food security

Food security is defined as access to sufficient, safe, and nutritious food at all times.[75] In 2015, the UN Sustainable Development Goals included a target to end hunger and achieve global food security by 2030. According to the Food and Agriculture Organisation (FAO), 2 billion people lack access to sufficient and nutritious food, while a total of 750 million people experience hunger.[76] The High Level Panel of Experts on Food Security and Nutrition (HLPE) reports a steady upward trend of people affected by severe food insecurity. The number of people affected by hunger is expected to surpass 840 million by 2030 with an additional 130 million people exposed to severe levels of food insecurity because of the coronavirus pandemic.[77] Competition for land and water will put further pressure on the fragile food and food supply systems. This competition will in part be driven by resource extraction as mining moves into new frontiers to extract materials to meet rising market demand.

[71] United Nations News. (2020, October,29). *Reduce risk to avert "era of pandemics", experts warn in new report*. https://news.un.org/en/story/2020/10/1076392
[72] World Health Organization. (2021, May 5). *WHO, Germany launch new global hub for pandemic and epidemic intelligence*. https://www.who.int/news/item/05-05-2021-who-germany-launch-new-global-hub-for-pandemic-and-epidemic-intelligence
[73] Billington, J., Deschamps, I., Erck, S. C., Gerberding, J. L., Hanon, E., Ivol, S., Shiver, J. W., Spencer, J. A., & Van Hoof, J. (2020). Developing vaccines for SARS-CoV-2 and future epidemics and pandemics: Applying lessons from past outbreaks. *Health Security, 18*(3), 241–249. https://doi.org/10.1089/hs.2020.0043
[74] Gopinath, G. (2021, January 26). A race between vaccines and the virus as recoveries diverge. IMF Blog. https://blogs.imf.org/2021/01/26/a-race-between-vaccines-and-the-virus-as-recoveries-diverge/
[75] High Level Panel of Experts on Food Security and Nutrition. (2020). *Food security and nutrition: Building a global narrative towards 2030*. Food and Agriculture Organization. http://www.fao.org/cfs/cfs-hlpe
[76] Food and Agriculture Organization. (2020, July, 13). *As more go hungry and malnutrition persists, achieving Zero Hunger by 2030 in doubt, UN report warns.* http://www.fao.org/news/story/en/item/1297810/icode/
[77] Food and Agriculture Organization. (2020). The state of food security and nutrition in the world 2020. http://www.fao.org/documents/card/en/c/ca9692en

*Figure 14: The distribution of hunger in the world in 2019 and 2030* [77]

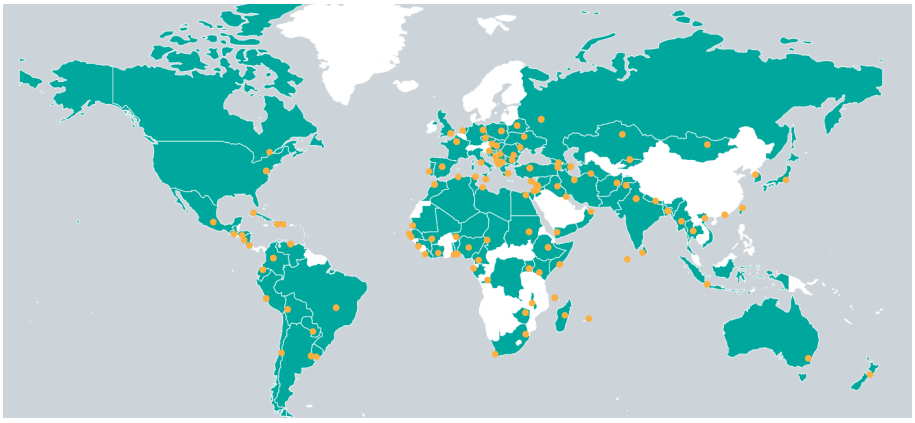



*Source: SOFI Report, 2020*

### 2.3.4 Protest and civil disorder

Protest and civil disorder events are on the rise. The Armed Conflict Location & Event Data Project (ACLED) reported 382,154 events in the period 2017–2021 with 492,629 fatalities. This marks an increase of 33% in the number of events and 36% in fatalities in that period. Events include battles, violence against civilians, riots, and protests.[78] The Mass Mobilization Data project, funded by the US Central Intelligence Agency, reported over 2,100 incidents of protest for the period 2017–2020.[79] A separate database, developed by the Carnegie Endowment for International Peace, recorded 230 significant protests in more than 110 countries specifically directed at governments. Almost 80% of these protests occurred in what are considered authoritarian or authoritarian-leaning states.[80] The implication for the resources industry is that contentious projects and activities could be the focus or trigger for protest or violence, even in jurisdictions where authoritarian-leaning regimes have historically limited these actions.

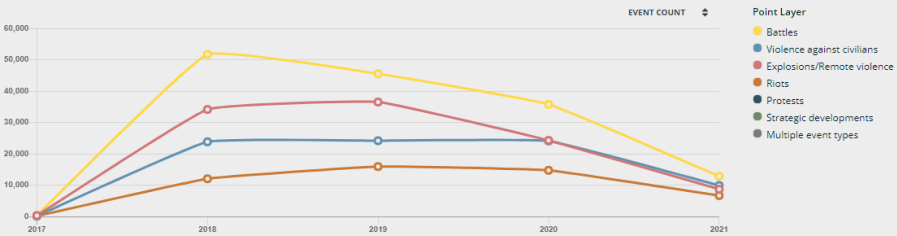
*Figure 15: Global protest tracker since 2017* [80]



*Source: Carnegie Endowment for International Peace, 2021*

[78] Armed Conflict Location and Events Data Project. (2021). *Dashboard*. https://acleddata.com/dashboard/#/dashboard
[79] Mass Mobilization Project. (2019). *Protests against governments, all countries, 1990-2020.* https://massmobilization.github.io/
[80] Carnegie Endowment for International Peace. (2021 June 3). *Global Protest Tracker*. https://carnegieendowment.org/publications/interactive/protest-tracker

*Figure 16: Number of global events and fatalities from April 2020 to April 2021* [78]

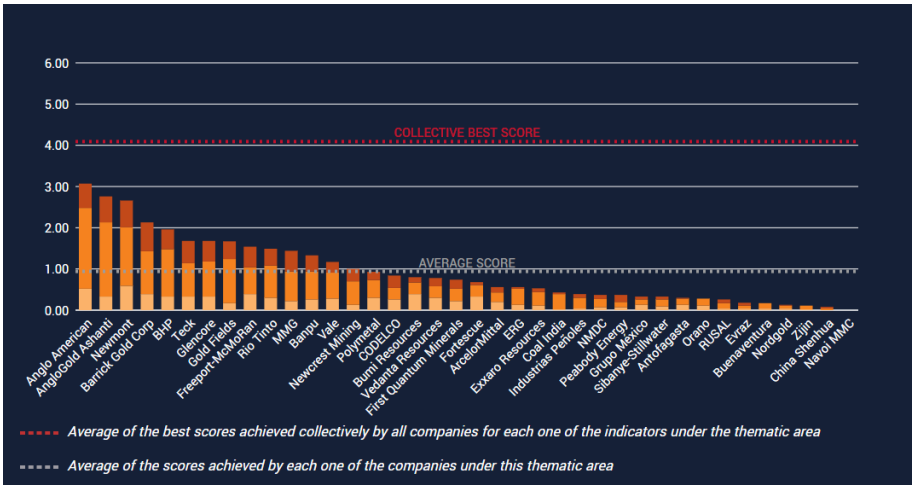



*Source: The Armed Conflict Location & Event Data Project, 2021*

### 2.3.5 Business and human rights

It has been 10 years since the UN General Assembly unanimously endorsed the Guiding Principles on Business and Human Rights (UNGPs). The Corporate Human Rights Benchmark (CHRB) reports that in 2020, 40% of listed mining companies reference specific standards of the UNGPs in their corporate policy frameworks.[81] Nonetheless, the practice of human rights due diligence (HRDD) in mining is low. The Responsible Mining Foundation (RMF) reports that in 2020, 85% of mining companies have not formally made a commitment to conduct HRDD.[82] Several jurisdictions have incorporated elements of the UNGPs into hard law. Between 2015 and 2021, the United Kingdom, Norway, France, Germany, Italy, Netherlands, and Australia introduced laws that include human rights due diligence and/or Modern Day Slavery laws.[83] In 2019, the European Union developed a legislative proposal requiring businesses to conduct due diligence in relation to potential human rights and environmental impacts of operations and supply chains, with sanctions for non-compliance. The global mining industry continues to face consistent allegations of egregious human rights abuse in its operations and supply chains. In 2019, the Business and Human Rights Resource Centre (BHRRC) launched a Transition Mineral "tracker" due to the high number of complaints and abuse allegations they receive from extractive industries. Pressure on the mining industry to improve performance in this arena remains strong.

*Figure 17: Average company score on human rights*[84]




*Source: Results from the Research Mining Index Report, 2020*

[81] Corporate Human Rights Benchmark. (2020). *Across sectors: Agricultural products, Apparel, Automotive manufacturing, Extractives & ICT manufacturing - 2020 Key findings*. https://www.worldbenchmarkingalliance.org/publication/chrb/

[82] Responsible Mining Foundation. (2020, July 22). *Human rights defenders: are mining companies playing their part?* https://www.responsibleminingfoundation.org/research/defenders2020/

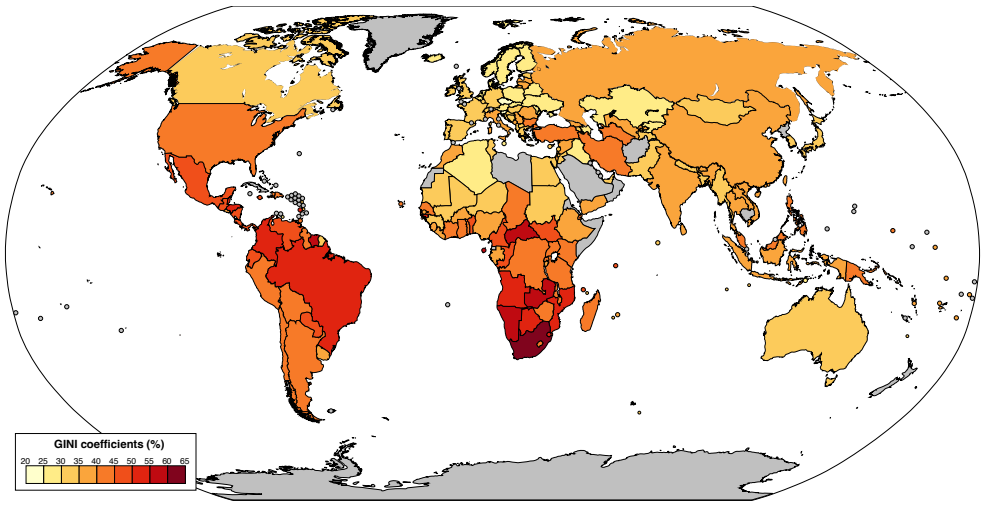
[83] Human Rights Watch (2021) https://www.hrw.org/news/2021/06/11/germany-new-supply-chain-law-step-right-direction and Walk Free. (2018). *The global slavery index*. https://www.globalslaveryindex.org/2018/findings/importing-risk/g20-countries/

[84] Responsible Mining Foundation. (2020). *RMI report 2020*. https://www.responsibleminingfoundation.org/rmi-report-2020/

### 2.3.6 Global inequality

Global inequality refers to the unequal distribution of resources among individuals and groups.[85] In 2020, the OECD reported that the average income of the world's richest 10% was nine times that of the poorest 10%, seven times higher than what it was 25 years ago.[86] The United Nations Department of Economic and Social Affairs' (UNDESA) predicts that four megatrends – technological innovation, climate change, urbanisation, and international migration – will further exacerbate inequality.[87] Roughly 70% of the global population currently live in countries with growing inequality. This includes OECD countries where large portions of middle-income households are considered financially vulnerable.[88,89] Resource development has the potential to reduce income inequality between countries but tends to exacerbate existing inequalities and drive new forms of inequality, particularly in locations where mining activities occur.

*Figure 18: The World Bank GINI Index of Global Inequality ranging from 1992 to 2018[90]*




*Source: Gini Index (World Bank), 2018*

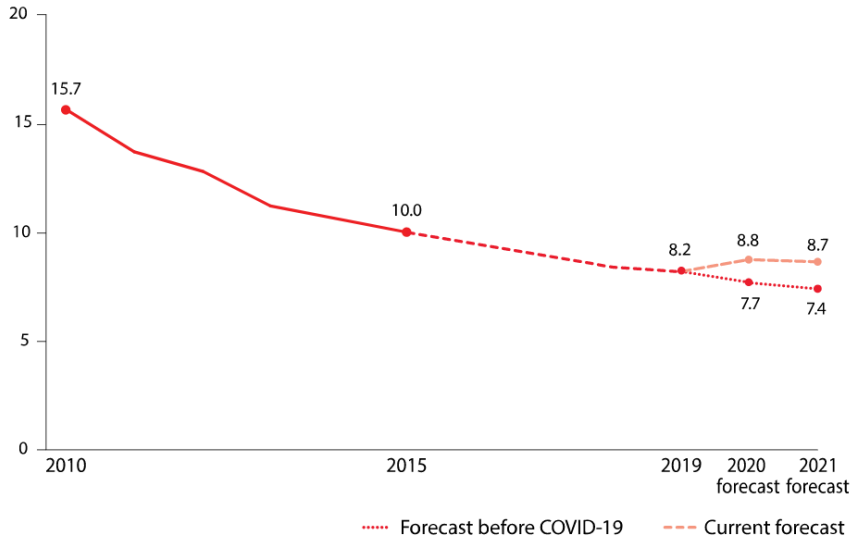
### 2.3.7 Sustainable Development Goals

The United Nations' 17 Sustainable Development Goals (SDGs) offer an ambitious call for action.[91] The process to finalise these goals took three years and remains the biggest consultation event in UN history.[92] Since the SDGs were first announced in 2015, progress has been slow across a majority of fronts including ocean health, youth unemployment, and the share of Less Developed Countries participating favourably in global export markets. According to the UN's latest progress report on SDGs released in 2020, for the first time in 20 years, the total number of people living in extreme poverty is set to rise (Figure 19).[93] The mining industry has a significant role to play in ongoing progress towards the SDGs given that it operates in some of the most disadvantaged, remote, and ecologically fragile landscapes. The sector's social and environmental

[85] World Bank Group. (2016). *Poverty and shared prosperity 2016: Taking on inequality*. https://www.worldbank.org/en/publication/poverty-and-shared-prosperity-2016
[86] Organisation for Economic Co-operation and Development. (2020). Inequality. https://www.oecd.org/social/inequality.htm#income
[87] United Nations Department of Economic and Social Affairs. (2020). *World social report 2020: Inequality in a rapidly changing world*. https://www.un.org/development/desa/dspd/world-social-report/2020-2.html
[88] World Bank Group. (2016). *Poverty and shared prosperity 2016: Taking on inequality*. https://www.worldbank.org/en/publication/poverty-and-shared-prosperity-2016
[89] Organisation for Economic Co-operation and Development. (2019). *Under pressure: The squeezed middle class*. https://www.oecd.org/social/under-pressure-the-squeezed-middle-class-689afed1-en.htm
[90] World Bank. (2019). *Gini Index*. https://data.worldbank.org/indicator/SI.POV.GINI
[91] Brookings Institution. (2020, September 16). *American leadership in advancing the Sustainable Development Goals* (Online Event). https://www.brookings.edu/events/american-leadership-in-advancing-the-sustainable-development-goals-2/
[92] Gaffney, O. (2015, September 16). *10 facts about the Sustainable Development Goals*. World Economic Forum. https://www.weforum.org/agenda/2015/09/10-things-to-know-about-the-sustainable-development-goals
[93] United Nations. (2020). *The Sustainable Development Goals Report 2020*. https://unstats.un.org/sdgs/report/2020/

performance has a direct bearing on the quality of life for its stakeholder communities and regions and the SDGs are a central design feature in corporate development programming.[94]

*Figure 19: Proportion of population (%) living below $1.90 a day, 2010–2015, 2019, and forecast before and after COVID-19*[95]




*Source: UNDESA, 2020*

### 2.3.8 UN Declaration on the Rights of Peasants (UNDROP)

Mining companies have received plenty of guidance on how to engage with Indigenous Peoples around their operations.[96,97] The latest version of the UN *State of the World's Indigenous Peoples* report re-iterates that what is essential is "the connection between indigenous peoples and their lands".[98] Less well known is that a *Declaration on the Rights of Peasants* (UNDROP) was adopted by the UN in 2018.[99] This declaration notionally covers a much larger part of the world's population. Peasants and other rural workers are now also recognised as having a "special relationship … [with] the land, water and nature", that they have basic rights to a clean environment and to genetic materials like seeds, and that they contribute to the conservation of biodiversity and help maintain food security – things that are integral to other agreed development objectives, such as the SDGs. But at the time of writing, the term "peasant" does not appear on the websites of industry associations.

Some issues concerning rural populations have been covered before: notably in the interactions between large-scale mines and artisanal and small-scale (ASM) miners. A big difference is that ASM miners may be migrants and may be seen as pursuing the same resource as large-scale miners: the relationship is therefore intrinsically competitive and conflictual. By contrast, peasants – and "other people working in rural areas" – may also have poorly-recognised rights but they will usually have a longer, perhaps a very long, history in the area. This space is one to watch for developments in law, especially in respect of operations in Africa, South America, and parts of Asia.

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[94] Responsible Mining Foundation. (2020). Mining and the SDGs: A 2020 status update. https://www.responsibleminingfoundation.org/mining-and-the-sdgs/

[95] United Nations Department of Economic and Social Affairs, Statistics Division. (2020). *End poverty in all its forms everywhere*. https://unstats.un.org/sdgs/report/2020/goal-01/

[96] Mining Association of Canada. (2019). *Indigenous and Community Relationships*. https://mining.ca/towards-sustainable-mining/protocols-frameworks/indigenous-and-community-relationships/

[97] Mineral Council of Australia. (n.d.). *Enduring value framework*. https://minerals.org.au/enduring-value-framework

[98] United Nations Department of Economic and Social Affairs. (2021). *State of the World's Indigenous Peoples: Rights to Lands, Territories and Resources,* (Volume 5). https://www.un-ilibrary.org/content/series/25186922

[99] United Nations Human Rights Council. (2018). *United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas*. United Nations Digital Library. https://digitallibrary.un.org/record/1650694

# 3. ESG and the future of copper

This section focuses on ESG issues as they relate to copper and copper markets.

## 3.1 Copper Market

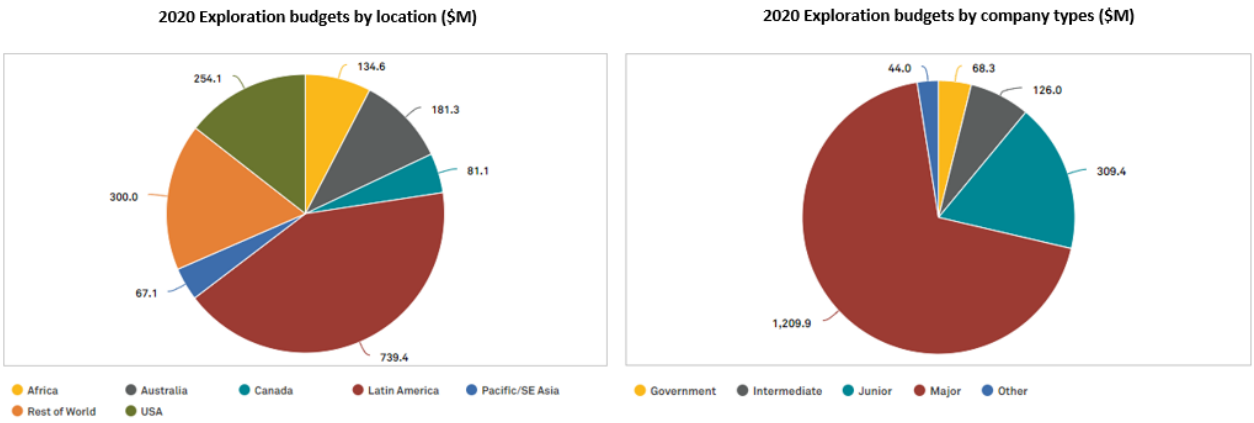
### 3.1.1 Demand

As the market for energy alternatives ramps up, and urbanisation and electrification continue to increase, record quantities of copper will be required. Global copper production currently sits at around 20 million tonnes per year. Some analysts predict this could reach 60 million tonnes by 2050,[100] which is a three-fold increase over the next three decades. The demand for copper and other energy transition minerals has sparked predictions of a commodity boom and a "golden age" for mineral exploration.[101] This timing coincides with the economics of the pandemic and a drive to stimulate macroeconomic recovery. Wealthier nations are expected to consume greater volumes of copper to drive major infrastructure initiatives and transition carbon-intensive energy systems. Under these conditions, market incentives are geared towards producing for a hungry market. The incentives for caution and responsibility have not been articulated.

### 3.1.2 Supply

The world is headed for a shortfall in the supply of copper. Commodities trader Trafigura Group estimates that the annual copper supply shortfall could be as high as 10 million tonnes by 2030 if no new mines are built.[102] In terms of resources in the ground, S&P Global Market Intelligence estimates 1 billion tonnes of copper sits in known undeveloped orebodies, while 1.7 billion tonnes sit in developed orebodies. The cumulative demand over the next 30 years, from 2020 to 2050, is projected to be around 1.2 billion tonnes[100] – representing about half today's known reserves and resources. Exploration will be key to increasing the resource base. There are major questions being raised by a broad spectrum of stakeholders about the supply gap and the safeguards in place to protect people and the environment in poorer communities in producing nations.

*Figure 20: 2020 global exploration budgets for copper by location and company type[103]*




*Source: S&P Global Market Intelligence, 2021*

[100] Elshkaki, A., Graedel, T.E., Ciacci, L., & Reck, B.K. (2018). Resource demand scenarios for the major metals. *Environmental Science & Technology, 52*(5), 2491–2497. https://doi.org/10.1021/acs.est.7b05154

[101] Bloomberg Professional Services. (2021, March 16). *The next commodity supercycle?*. Bloomberg. https://www.bloomberg.com/professional/blog/the-next-commodity-supercycle/

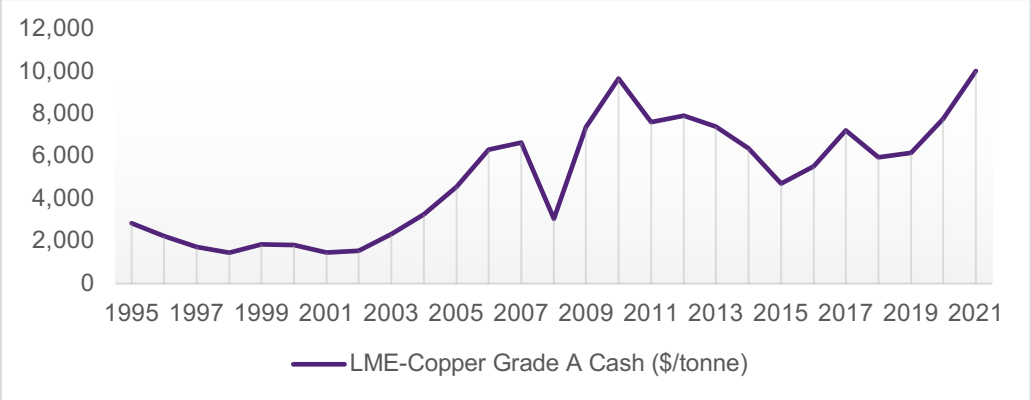
[102] Bloomberg News. (2021, May 19). *The world will need 10 million tonnes more copper to meet demand*. MINING.COM. https://www.mining.com/web/the-world-will-need-10-million-tonnes-more-copper-to-meet-demand/

[103] S&P Global. (2021). *Commodity profile.* S&P Global Market Intelligence. https://platform.marketintelligence.spglobal.com/web/client?auth=inherit#industry/commodityProfile

### 3.1.3 Price

Until recently, the copper market has been flat. At a 10-year average of $2.70 per pound, prices had dampened investor enthusiasm. Current prices supported by a strong outlook for copper have given miners an incentive to explore, acquire, expand, and bring greenfield copper projects into development. There is uncertainty as to whether, and for how long, prices will remain high.[104] A future drop in price could mean that higher-cost projects that are currently in development with an attractive NPV will struggle and may eventually stall. Freeport Chief Executive Officer Richard Adkerson recently told an industry gathering that even if copper soared to $10 a pound tomorrow, it would take his company seven or eight years to get new product to the market.[102] Moreover, most ESG mitigation measures are capital intensive and could further erode NPV – unless the case for continuing to externalise the cost of ESG mitigation measures can be made.[105] Conversely, should copper prices keep rising, a recent report warns that this could make clean energy technologies costly and delay their deployment.[33] Chinese and other state-owned enterprises are not as affected by these price trends compared to public companies.

*Figure 21: Evolution of copper prices over a 25-year period* [103]




*Source: S&P Global Market Intelligence, 2021*

### 3.1.4 Investment

Investors claim to be integrating ESG factors into their investment decisions.[106] The United Nations Principles for Responsible Investment (UNPRI), launched in 2006, now have over 3,000 signatories.[107] Mining CEOs appear to be sensitive to investor questions and claims, with CEO surveys identifying ESG risks as the top challenges in the industry.[108] The extent to which investors will support capital investment for ESG measures, such as to control emissions and achieve long-term energy efficiencies, and at the same time accept a reduction in NPV and long-term profitability remains to be seen. Likewise, the extent to which investors will demand improvements in operational-level social performance – aside from when there is an obvious issue or significant social pressure – is an open question. While there may be doubts, investors have rapidly dis-invested from thermal coal, based on ESG concerns,[109] which has had a major effect on the entire sector. Climate change mitigation is now the top objective among responsible investors, at the risk of taking priority over other ESG matters.[108]

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[104] Krause, R. (2021, May 17). *Mining stocks gleam as copper, the red metal, becomes the "green metal"*. Investor's Business Daily.https://www.investors.com/news/mining-stocks-how-copper-the-red-metal-is-becoming-the-green-metal/

[105] Externalisation means that the cost is not carried by the developer, but by other parties.

[106] Broughton, K., & Maurer, M. (2021, June 14*). Companies spend big on ESG investments, hoping for long-term payoff*. Wall Street Journal. https://www.wsj.com/articles/companies-spend-big-on-esg-investments-hoping-for-long-term-payoff-11623670200

[107] Principles for Responsible Investment [PRI], United Nations. (2021, June 20). *Signatory directory*. https://www.unpri.org/signatories/signatory-resources/signatory-directory

[108] Campbell, R., Tivery, J., & Wright, O. (2021, January 13). *Mining and metals 2021: ESG momentum reaching a crescendo in a resilient market*. White & Case. https://www.whitecase.com/publications/insight/mining-metals-2021-esg-momentum-reaching-crescendo-resilient-market

[109] Chalmers, S. (2020, January 15). *World's largest fund manager BlackRock cuts thermal coal exposure on climate concerns*. ABC News. https://www.abc.net.au/news/2020-01-15/worlds-largest-fund-manager-to-cut-thermal-coal-exposure/11869300

## 3.2 Copper as a Commodity

### 3.2.1 Grade

Most of the world's easily accessible, higher-grade copper deposits have been depleted. Glencore's Kamoa-Kakula project in the Democratic Republic of Congo (DRC) is an exception. Miners have been compensating for declining grades through technology advancements, and increased throughput. Copper has experienced continued long-term increases in production as innovation has allowed lower grades to be mined profitably. Copper mining of the future will involve deeper, underground mining, and more challenging techniques and technologies, such as block caving, which incur significantly higher technical risk and upfront capital costs. Developing these deposits will require high copper prices to attract investment. If prices conditions are not met, grade decline could remove 2 million tonnes of copper supply by 2030.[110]

### 3.2.2 Cut off

Most cost models and market forecasts are based on reported resource grades of copper. Given the impending supply shortfall and price increases, it is likely that copper cut-off grades will drop below those currently used to estimate those resources, and the overall grades will drop accordingly. Modelling and forecasting will have to adjust.

### 3.2.3 Penalty elements

The greater prevalence of mines that are deeper and lower grade will also mean a greater prevalence of mines that generate deleterious or "penalty" elements such as arsenic,[111] cadmium, and fluorine, the latter of which has more recently captured the attention of markets. The presence of deleterious elements is difficult to predict and is quite specific to individual deposits. Nonetheless, the presence of deleterious elements in copper concentrates increases the cost of downstream processing for smelters, which incurs penalties for miners, reducing the value of the product. The extent to which this affects profitability will depend on price. A standard penalty imposed in the context of high prices may represent increased profitability per unit of copper. In other words, high prices may, in effect, neutralise the financial effect of any penalty incurred.

### 3.2.4 Waste

Deeper, lower grade orebodies mean that new copper mines are likely to generate more waste rock and more tailings. If projected demand is met, and assuming that copper cut off grades fall below 0.4% copper, we estimate that for the period 2000–2050 the world will produce more than nine times the amount of copper tailings in the entire century prior. This will place pressure on land use, as waste rock dumps and tailings storage facilities comprise the greatest proportion of the mine footprint, covering between 26% and 81% of a mine site's area.[112] Increased amounts of waste will heighten land use competition, especially in rural and remote communities, and on the lands of Indigenous and First Nations Peoples, as well as heighten the risk of waste-induced incidents and impacts throughout the mine lifecycle, including closure.

### 3.2.5 Land

Our research from 2019 found that almost half (47%) of undeveloped copper reserves and resources occur on, or in close proximity to, Indigenous Peoples' lands, and 64% within, or near, areas critical to biodiversity conservation.[113] An estimated 40% of undeveloped copper reserves and resources are located in areas

[110] McKay, H. (2021, February 17). *BHP's economic and commodity outlook (FY21 half year)*. BHP. https://www.bhp.com/media-and-insights/prospects/2021/02/bhps-economic-and-commodity-outlook/

[111] Schwartz, D.M., Omaynikova, V.Y., & Stocker, S.K. (2017, June 21-23). *Environmental benefits of the CESL Process for the treatment of high-arsenic copper-gold concentrates* [Paper presentation]. International Conference on Metal Solvent Extraction, Santiago, Chile. https://www.teck.com/media/Environmental-benefits-of-the-CESL-Process-for-the-treatment-of-high-arsenic%20copper-gold%20concentrates.pdf

[112] Werner, T.T., Mudd, G.M., Schipper, A.M., Huijbregts, M.A.J., Taneja, L., & Northey, S.A. (2020). Global-scale remote sensing of mine areas and analysis of factors explaining their extent. *Global Environmental Change, 60*, 102007. https://doi.org/10.1016/j.gloenvcha.2019.102007

[113] Lèbre, É., Owen, J.R., Corder, G.D., Kemp, D., Stringer, M., & Valenta, R.K. (2019). Source risks as constraints to future metal supply. *Environmental Science & Technology, 53*(18), 10571–10579. https://doi.org/10.1021/acs.est.9b02808

dominated by human land uses, notably agriculture. Land use competition is not a new problem in mining, but with larger mines and larger waste profiles, land use competition is set to be a more widespread challenge, as exploration and extraction ramps up.

### 3.2.6 Water

Mining is water intensive, particularly during the separation and transportation of ore and tailings. If copper mining ramps up to meet demand, there will not only be competition for land, but also for water. Our research from 2019 found 65% of undeveloped copper reserves and resources are in areas with high water risk, meaning that miners would likely compete for water resources among other local water users. This percentage does not account for locations where water is available in such high quantities that waste containment would be challenging, leading to pollution and contamination of waterways. Furthermore, exposure of ore to water or air can have generate hydrogeochemical hazards and risks in local waterways.

### 3.2.7 Legacies

Large-scale mines can leave damaging social and environmental legacies. It is estimated that more than 50,000 mines are abandoned in Australia,[114] at least 10,000 in Canada,[115] and estimates for the United States vary between 60,000[116] and 500,000 abandoned mines.[117] Despite changing policy guidance[118] and an increased public awareness about the impact of mine abandonment, examples of successful attempts at planned mine closures are scarce.[119] Research indicates that divestment continues to be a dominant practice for limiting closure liabilities by mining corporations.[120] Host jurisdictions are proactively instituting protective measures against companies avoiding their closure obligations through permitting and the use of financial bonds.[121] The conditions create additional hurdles at feasibility. Copper projects are well represented in this history. In Australia, for example, when the century-old Mount Lyell copper mine in Tasmania was abandoned in the early 1990s, it left a legacy of acid mine drainage and other environmental issues. Likewise, the abandoned Redbank copper mine in the Northern Territory has leached 54,000 tonnes of acid-forming material into local waterways over three decades. The estimated cost for the state and territory governments to clean up these mines is in the order of several billions of AUD.[122] There is a reluctance on the part of governments to formally accept these legacy costs. Abandoned copper mines have also left damaging legacies in some of the world's most fragile states. One of the most infamous is the Panguna copper mine in Bougainville, Papua New Guinea. In 1989, environmental impacts and disputed revenue sharing forced the closure of the mine, sparking a civil war. Three decades later, allegations of human rights abuses related to Rio Tinto's abandonment of the mine remain a live issue. Host states and local communities are often left with significant costs from these types of legacies, usually in the absence of a mine owner or operator to take responsibility for remedy.

[114] Unger, C., Lechner, A. M., Glenn, V., Edraki, M., & Mulligan, D. (2012, July 10-12). Mapping and prioritising rehabilitation of abandoned mines in Australia [Paper presentation]. *Life of Mine Conference (AusIMM)*, Brisbane, Australia. Australasian Institute of Mining and Metallurgy. https://espace.library.uq.edu.au/view/UQ:283801

[115] Mining Watch Canada. (2009, June 4). *Abandoned mines: Overview*. https://miningwatch.ca/blog/2009/6/4/abandoned-mines-overview

[116] Earthworks. (n.d.). *Abandoned mines*. https://www.earthworks.org/issues/abandoned_mines/

[117] Abandoned Mines. (n.d.). *Introduction*. U.S. Bureau of Land Management. https://www.abandonedmines.gov/extent_of_the_problem

[118] International Council on Mining and Metals. (2020). *Closure maturity framework*. https://www.icmm.com/en-gb/guidance/environmental-stewardship/closure-maturity-framework

[119] Crous, C., Owen, J.R., Marais, L., Khanyile, S., & Kemp, D. (2021). Public disclosure of mine closures by listed South African mining companies. *Corporate Social-Responsibility and Environmental Management, 28*(3), 1032–1042. https://doi.org/10.1002/csr.2103

[120] Lèbre, É., Owen, J.R., Stringer, M., Kemp, D., & Valenta, R.K. (2021). Global scan of disruptions to the mine life cycle: Price, ownership, and local impact. *Environmental Science & Technology, 55*(8), 4324–4331. https://doi.org/10.1021/acs.est.0c08546

[121] Kung, A., Everingham, J., & Vivoda, V. (2020). *Social aspects of mine closure: governance & regulation*. Centre for Social Responsibility in Mining. The University of Queensland. https://www.mineclosure.net/elibrary/social-aspects-of-mine-closure-governance-regulation

[122] Mining Technology. (2015, April 12). *Managing Australia's 50,000 abandoned mines*. https://www.mining-technology.com/features/featuremanaging-australias-50000-abandoned-mines-4545378/

## 3.3 Governance

### 3.3.1 Criticality

Mineral criticality is typically defined by availability and accessibility at a country level. There is much variation as to whether countries classify copper as critical. Canada lists copper as critical,[123] whereas Australia, for the time being, does not.[124] These "critical minerals" lists may start to inform whether markets remain open and transparent, or close down, to safeguard supply amongst allied nations. Nonetheless, copper is critical to the low-carbon energy transition. If the supply of copper slows or stalls, our ability to transition our energy systems and combat climate change will be put at great risk.[33]

### 3.3.2 Key jurisdictions

Jurisdictions of greatest complexity for copper include Chile, Peru, the Democratic Republic of Congo (DRC), Zambia, Indonesia, and Mongolia. Chile and Peru produce approximately 38% of mined copper and hold 33% of the world's undeveloped copper orebodies. The mining sector in these countries has been remarkably resilient considering social and political instability, but this is set to change. The re-writing of Chile's Constitution, for instance, could have major implications for mining.[125] Elsewhere, Zambia has changed its mining royalty and tax regime 10 times in 20 years and has been embroiled in disputes with several major mining corporations.[126] Mongolia and Indonesia are advancing their efforts to nationalise their natural resource endowments, and the DRC grapples with corruption, while pushing a local beneficiation strategy. According to our research, 50% of the world's known copper reserves and resources are in socially and politically fragile countries, such as the DRC.

### 3.3.3 Law and regulation

Many mining projects are facing greater scrutiny over ESG issues at the approvals and permitting stage. At the current juncture, Pebble in Alaska is the most significant project to be held back on environmental grounds. Public opposition towards large-scale copper projects means they could face difficult legal battles before these projects are permitted to go ahead. The Biden administration in the USA, for instance, is likely to support stricter environmental thresholds at the approvals stage.[127] Globally, different jurisdictions are beginning to introduce specific regulatory provisions to reflect their ESG risk profile. Water stressed Chile, for instance, is looking to mandate desalination for the use of water for mining.[128] This could test the feasibility thresholds for projects that are critical to addressing the forthcoming copper supply gap.

## 3.4 Copper Supply Chain

### 3.4.1 Substitution

Higher copper prices may lead to more substitution with cheaper alternatives, which could ease shortfalls. Aluminium is the metal that benefits most from the substitution of copper. Nonetheless, substitution rates of copper remain extremely low, largely because copper has superior properties of conductivity, and heat and corrosion resistance. The International Copper Association concludes that the impact of substitution is less than 1% across the global copper market.[129] Chile's copper agency, Cochilco explains that customers would

[123] Government of Canada. (2021, March 29). *Critical minerals*. https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/critical-minerals/23414

[124] Department of Industry, Science, Energy and Resources, Australian Government. (2019). *The opportunity for the critical minerals sector*. https://www.industry.gov.au/data-and-publications/australias-critical-minerals-strategy/the-opportunity-for-the-critical-minerals-sector

[125] Cambero, F. (2020, November 5). *Chile's mining investment to lag while constitution rewritten, official says*. Reuters. https://www.reuters.com/article/chile-copper-idUSL1N2HQ1WS

[126] Extractive Industries Transparency Initiative. (2021, June 1). *Zambia: Overview.* https://eiti.org/zambia

[127] Eilperin, J., Dennis, B., & Muyskens, J. (2021, June 18). *Tracking Biden's environmental actions*. Washington Post. https://www.washingtonpost.com/graphics/2021/climate-environment/biden-climate-environment-actions/

[128] Mining Magazine. (2015, June 8). *Chile closer to mandating desalination*. https://www.miningmagazine.com/natural-resources/news/1262046/chile-closer-mandating-desalination

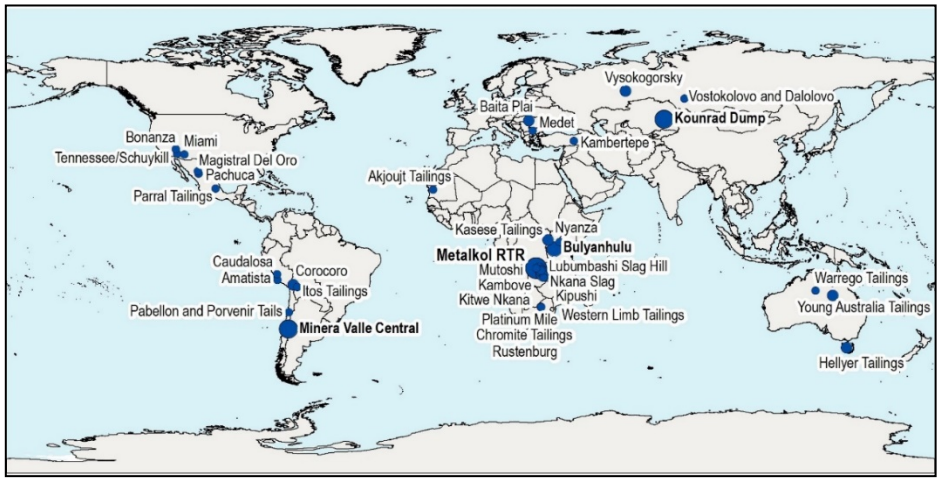
[129] Copper Development Association. (n.d.). *Copper Recycling and Sustainability 2.* Copper Alliance Ltd. https://copperalliance.org/trends-and-innovations/substitution/

have to be comfortable that any cost gains were worth the research efforts and any losses in conductivity, which would, in the end, undermine the search for greater energy efficiency as part of a decarbonisation strategy.[130]

### 3.4.2 Recycling and the circular economy

The recycling potential for copper is high, as the metal retains its properties and most of its value in the process.[131] Recycling schemes for copper are mature, with recycled copper currently covering about 30% of the global demand.[132] Europe is the recycling leader, with almost 50% of its current copper demand already met with recycled material.[133] Recycling is generally put forward as a cleaner and cheaper alternative to mining, although energy requirements at 10GJ per tonne of recycled copper are still significant. While recycling rates can be improved, they will be constrained by the increasing complexity of copper-containing waste products. For copper to be recycled, it needs to undergo the traditional smelting and refining route, which is energy intensive and generates hazardous waste. With these constraints, alongside increasing copper demand, we anticipate that copper recycling will not significantly offset the need for mined copper in the short, medium, or longer term. Copper miners could contribute to recycling efforts by reprocessing waste from mining, mineral, and metallurgical processes, which form the largest pool of copper waste in mining countries.[134] An analysis of the S&P Global Market Intelligence database identified a small number of copper tails reprocessing projects at the operational stage, located for the most part in developing countries. Innovative leasing systems where metal suppliers retain ownership of product is a new approach that may at some future point support a circular economy.[135]

*Figure 22: The 38 operating copper tailings re-processing projects around the world* [103]




*Note: Dot size is proportional to amount of copper contained in reserves and resources in tailings.*

*Source: Adapted from S&P Global Market Intelligence, 2021*

[130] Burton, M., & Attwood, J. (2021, February 26). *Copper's spike stirs alarm over another rush to find substitutes.* Bloomberg. https://www.bloomberg.com/news/articles/2021-02-25/copper-s-spike-brings-back-supercycle-era-fears-of-substitution

[131] https://copperalliance.org.uk/knowledge-base/education/education-resources/copper-recycling-sustainability-2/

[132] Loibl, A., & Tercero Espinoza, L.A. (2021). Current challenges in copper recycling: Aligning insights from material flow analysis with technological research developments and industry issues in Europe and North America. *Resources, Conservation and Recycling, 169*, 105462. https://doi.org/10.1016/j.resconrec.2021.105462

[133] Lacasse, K., & Hanson, N. (2019). *Copper and the circular economy: Challenges and solutions.* International Copper Association Ltd. https://copperalliance.eu/copper-circular-economy-challenges-opportunities-solutions/

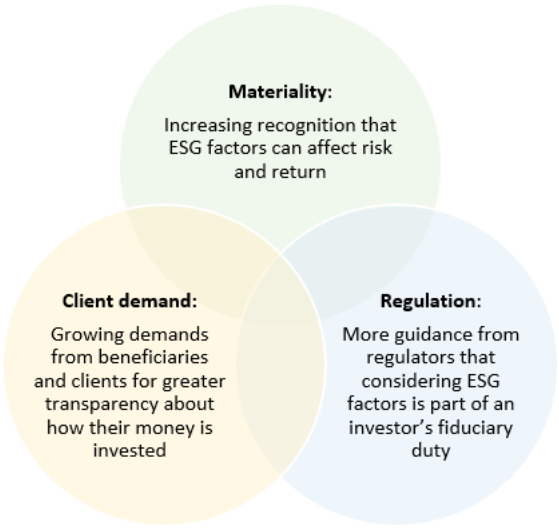
[134] Gordon, R.B. (2002). Production residues in copper technological cycles. *Resources, Conservation and Recycling, 36*(2), 87–106. https://doi.org/10.1016/S0921-3449(02)00019-8

[135] International Council on Mining and Metals (2016). *Mining and metals and the circular economy*. https://www.extractiveshub.org/servefile/getFile/id/7498

### 3.4.3 Standards and schemes

Originally developed for minerals mined in conflict-affected regions, chain-of-custody certifications are meant to give consumers assurance about the source of the products they buy. These schemes have recently extended to all mined minerals, for instance through the Initiative for Responsible Mining Assurance (IRMA) Standard, published in 2018.[136] Major copper consumers have joined IRMA, including BMW, Ford, and Microsoft. In fact, there has been noticeable increase in expectations for responsible metals through supply chains, with major companies such as Google, Samsung, BMW, and Volvo backing calls for a moratorium on deep sea mining in 2021,[137] and the London Metal Exchange introducing responsible sourcing requirements for all listed brands in 2019.[138] The latest scheme specific to copper is The Copper Mark, initiated by the International Copper Association in 2021. The scheme assesses the performance of mining entities against 32 environmental, social, and governance issues.[139]

*Figure 23: Several forces driving the growth of responsible investment* [107]




*Source: Adapted from UN-PRI, 2021*

[136] Initiative for Responsible Mining Assurance. (n.d.). *Standard*. https://responsiblemining.net/what-we-do/standard/
[137] Reuters. (2021, March 31). *Google, BMW, AB Volvo, Samsung back environmental call for pause on deep-sea mining*. https://www.reuters.com/business/sustainable-business/google-bmw-volvo-samsung-sdi-sign-up-wwf-call-temporary-ban-deep-sea-mining-2021-03-31/
[138] London Metal Exchange. (2021). *LME resources sourcing*. https://www.lme.com/en-GB/About/Responsibility/Responsible-sourcing
[139] Copper Mark. (2021, March 4). *The copper mark chain of custody standard terms of reference*. The Copper Mark Company. https://coppermark.org/wp-content/uploads/2021/05/The-Copper-Mark_Chain-of-Custody_ToR_4MAR2021.pdf

# 4. Reflections for the copper industry

This final section of the paper poses a series of 12 questions on key ESG-related challenges for the industry to reflect upon. The questions provide an indication of the types of challenges that the industry will need to reconcile as it engages with the ever-evolving ESG landscape for copper.

The questions are indicative and are not intended to be exhaustive. The process described below offers a starting point for engaging with the breadth of content that has been compiled across the four preceding sections. Each of the questions are global in orientation and require individual teams to consider the type of issues that lie at the core of each question from several vantage points.

These are questions for which there is no simple, one-dimensional answer, and where answers will most certainly change over time. The value in this exercise is not the "quick fix" formulated on first pass – the value lies in how the answer evolves as it is considered from different vantage points under different possible conditions and circumstances. Common understandings, areas of misalignment, and gaps in knowledge within individual teams, and between the company and different stakeholder groups, will become apparent. This is important information for the industry to consider as it builds future strategies.

To guide the process of thinking and reflection, this section provides "prompts" for the team to use in exploring the questions (Table 9). The prompts take into account the temporal, market, geopolitical, business, and disciplinary factors that will inform how the industry reads the conditions that sit alongside these questions, and which will necessarily structure how decisions are made (Table 10).

A suggested process would be for companies to assign teams to convene and work through the questions collectively. This would involve considering the question and the prompts, reflecting on the issues it raises, and formulating provisional answers or pathways forward. Responses should be captured for comparison and re-visited over time. As new information and data come to light, answers and strategies can be adjusted, and new questions added.

**Table 2: Emerging questions, prompts, and issues**

| Emerging questions | Prompt | Issues |
|---|---|---|
| **1. What will become the new norm for assessing the ESG risks of complex copper projects?** | Consider the level of knowledge required to support emerging due diligence mechanisms and schemes. This needs to be judged against changing tolerances for different kinds of risk, for different parties, and at different project stages. What types of evidence and assurance will the company's own investment committee or governments require? What will be asked of teams with the "ESG insights"? How will issues be tracked, and prioritised – and across the portfolio and future acquisitions? | • Knowledge and evidence<br>• Standards and schemes<br>• Evolution of mega-trends<br>• ESG risk tolerance<br>• Internal capability |
| **2. Will the copper price rise keep up with the higher technical and ESG costs of bringing challenging projects to market?** | To make the new energy economy affordable, there must be a natural upper limit on the price of copper. A rise in price will stimulate the movement of some challenging projects. In some cases, the challenges are going to be predominately technical. In other cases, the challenges may end up being ESG related, where a rise in price may not assist at all in alleviating the issues. Where are the "fail to start" projects in the pipeline? What will stall, what will be | • Affordability of the transition<br>• Market volatility<br>• Price insensitivity |

| | | | |
|---|---|---|---|
| | | carried by a buoyant copper price? What will the company's asset portfolio look like after copper prices fall? | |
| 3. | **What are the advantages of preferencing so-called "safe jurisdictions"?** | While "safe jurisdictions" tend to be OECD nations with advanced human development indicators, ready to mobilise infrastructure and a skilled workforce, they also tend to be more openly democratic. This translates into more robust systems of law with far higher expectations of transparency and accountability. Sub-national conditions in these jurisdictions can vary markedly from national averages. These jurisdictions often have Indigenous populations with specific rights that have a direct bearing on resource development projects. | • Human development indicators<br>• Sub-national data<br>• Transparency and accountability<br>• Indigenous rights<br>• "Safe" jurisdictions<br>• Consultation and consent |
| 4. | **What is the company's position on consultation and consent?** | The guidance on this topic has not progressed beyond high-level principles, while the practical conditions on the ground have intensified. This question strikes at the heart of how companies plan to establish terms with local partners. Is the company prepared to hold a company-defined line on this topic? Under which conditions would the company consider deviating from this position? | • Indigenous Peoples' rights<br>• Local partnerships<br>• Corporate commitments<br>• Deviation |
| 5. | **What benefit-sharing arrangements do you envisage being viable into the future?** | Automation and artificial intelligence may eliminate employment opportunities. What projections has the company made with respect to the future of work more generally in the economy? Given the global trends noted earlier in this paper, what resources and opportunities can the company leverage as part of its value proposition to local communities? | • Automation<br>• Technology<br>• Future of work<br>• Agreement making |
| 6. | **Beyond the supply of metals, how else will the company demonstrate its environmental credentials?** | Climate change is driving a new environmental consciousness that is especially strong in younger generations. In many jurisdictions, but particularly in OECD countries, people are unwilling to accept higher environmental risks than those already posed by climate change. | • Future generations<br>• Climate risk<br>• Other environmental risks |
| 7. | **What internal governance structures will the company adopt to account for the greater prominence of ESG risks and challenges?** | The nature and composition of mining company Boards and Executive Teams has not changed substantially in decades. The industry seems intent on retaining the status quo, rather than adjusting to a rapidly changing external landscape. Are current governance conventions defensible? How might they be adjusted? Where and when will the demand for change come from – will it be voluntary, or imposed by states or investors seeking greater confidence in corporate oversight regimes? | • Internal governance<br>• Adaptability<br>• Drivers of change |

| | | |
|---|---|---|
| **8. Where do you draw the line on ESG risks in terms of a no-go project?** | This question must be considered in terms of risk to whom? Does pressure to proceed, or to forgo an opportunity come in the form of new joint ventures with atypical partners, or something else? How does the company articulate, or disclose these thresholds to the market, and how would it know if a threshold has been reached? | • Risk tolerance<br>• No-go conditions<br>• Joint ventures<br>• Market disclosures |
| **9. Which ESG risks does the company expect to dominate the copper portfolio?** | Both the global trends and copper specific ESG issues reveal challenges for the company. Which trends or combinations of issues does the team consider to be most likely? Which are regarded as having the greatest negative effect on the business? Where are the opportunities for leadership and innovation from an ESG perspective? | • Copper's uniqueness<br>• Leadership and innovation<br>• Navigating complexity |
| **10. How does the company expect ESG factors to play into its choice of development partners?** | Consider the effect of ESG factors at multiple scales: globally, nationally, regionally, and locally. Which factors, at which scale, will take priority as a rule? Who will get what under this renewed perspective on risk and opportunity? | • Geo-politics<br>• Value proposition<br>• Partnerships |
| **11. How will the investor community reconcile the boom-pandemic dynamic with respect to waste and tailings?** | For countries hardest hit by the pandemic, such as Brazil, Chile, and India, the resource sector represents one of the few viable sources of big state revenue for rapid economic recovery. These countries can be expected to demonstrate resistance to any disclosure measures that will disrupt the flow of revenue into states at this time, or pressurise other industry actors, who have not made a commitment to align with the latest set of standards. Where does this leave the ICMM and its members? | • Pandemics<br>• Economic recovery<br>• Waste<br>• Water<br>• Tailings<br>• Disclosure |
| **12. How will present and future legacy sites be managed?** | What types of assets will fall into the "legacy site" category – either as a result of increasingly complex national conditions during the "copper rush" – or because of the inevitable downturn that will follow? What will be baked into the future copper market? | • Post-boom conditions<br>• Long term legacies<br>• Future market conditions |

**Table 3: ESG dimensions to consider for all questions**

| Dimension | Description |
|---|---|
| **Time horizon** | What could this issue/context/opportunity look like in 12 months, 5 years, 10 years, and beyond? |
| **Market pressures** | How will market pressures bear upon this issue? Could a project or group of projects attract special attention due to supply shortages? |
| **Geopolitical factors** | Which actors or group of actors at the international level are expected to be most influential in driving this issue? |
| **Organisational priorities** | Where does this sit within the company's order of priorities? |
| **Available capabilities** | What resources and capabilities will the business mobilise to do this work – and to make the connections from the global level through to assets? |

In conclusion, this paper has outlined a series of global trends, ESG trends for copper, and ESG risks specifically relating to copper. The paper increases the level of cognisance of non-mining trends, and how these issues may come to affect the way copper projects are designed, permitted, operated, and closed.

A key question is whether companies will drive thinking in this arena or will be ideas-takers (as they are "price takers"). Investors will certainly be weighing these ESG risks to suit their own priorities. Will companies? In other words, will the companies consider how these changes will affect the people and the environments in which they seek to operate, or wait to see what investors expect them to prioritise.

There is no doubt that copper and other energy transition minerals are necessary in vast quantities if emissions targets are to be reached. However, the race to rapidly develop resources, and to achieve a quantum leap in the availability of new technologies will put pressure on the environment and the communities closest to these projects. Responding to climate pressures in this fashion, and at this pace, will exacerbate the global pressures associated with industrialisation, and the scramble for resources and technologies will test an already fragile set of international relations. We are already seeing geopolitics play out in the aftermath of the pandemic, as China continues with its Belt-and-Road initiative, while allied countries launch their counter-schemes, the Blue Dot Network, or the recently announced "Build Back Better World" (B3W) initiative.

For copper producers, urbanisation, infrastructure, and investment in mega-projects will further push the demand for materials. To what extent will producers be expected to support one scheme over another, or will they fly under the radar, benefitting from the competition in the international sphere. What standards will be applied to these schemes? Where is the balance for companies between enlightened and pure self-interest, and what difference could technologies that drive "traceability" expose opportunism in a company's standards of practice? What will be the effects of rapid developments in "track and trace" in the global economy and the market for minerals and metals?

Wherever these and other trends land, global ESG issues are becoming more complex, and local issues more visible. To what extent will the copper boom support global or local systems? The global megatrends point to the importance of local-scale systems for energy and food security. Similarly, the influence of pandemics and increasing vulnerability in the "internet of things" will be consequential in terms of continued trust in the global system. This follows almost a decade of nation-states retreating into themselves, with many disconnecting from global norms and regional trade blocs. Will a copper boom drive us further into this direction, enabling smaller systems, rather than global systems? What will this mean for the global mining company model on which many companies have developed and operate? If the company teams consider these kinds of existential questions, then this think piece will have achieved its aim.

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

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## Contact details

**Prof. Deanna Kemp**
T +61 7 **3346 4003**
E **d.kemp**@smi.uq.edu.au
W smi.uq.edu.au

CRICOS Provider Number 00025B