



Transition Minerals

March, 2025

Transition mineral supply chains urgently need to be made more resilient, so they thrive rather than just survive in the face of climate shocks coming in the next 5-10 years. TMP is working on a three-and-a-half-year initiative, generously funded by the Hewlett Foundation and the Quadrature Climate Foundation, to prepare decision-makers and communities for these shocks and their repercussions.

Our aim is to ensure ongoing access to the minerals essential for rapid decarbonization. In the process, we need to catalyze international cooperation at a time of growing global geopolitical tensions, while improving the impact of the sector for local communities and ecosystems. To succeed, we need to persuade key decision-makers in business, government and civil society to take urgent, targeted and collaborative action. This document explains how we expect to do that.

About TMP

Founded in 2009, TMP is a dedicated group of experts focused on complex social, environmental and security problems. We have conducted analyses in 59 different countries across six continents, including field work in 33 nations. During field visits in the 2010s, we saw first-hand that climate change was a greater and more immediate problem than desk-based research and available climate models suggested. We realized that weather extremes in the 2020s could easily accelerate past many societies' capacities to manage them and that urgent action was needed. Find out more at www.asktmp.com.

Climate risk and Transition Minerals in the 2020s

Mineral supply chains for transition technologies like renewables, electric vehicles and grid infrastructure need to expand rapidly, which is now widely understood. Ironically, it is less well recognized that extreme weather events (EWEs)¹ and other climate-related phenomena are paramount risks for these “transition mineral” (TM) supply chains.² These risks are manageable, in our view, but only if urgent and concerted action is taken now to prepare for them.

Climate-related risks - like more frequent droughts and flood-related tailings dam failures - are already hurting TM extraction and processing. More importantly, physical climate impacts are agitating existing challenges for the sector, like social license, environmental sustainability and trade disputes. As such, increasing supply chain resilience demands improvements in social and environmental performance. Near-term risks are high but so are the rewards of managing them.

TMP’s work on TMs is part of our broader climate change initiative – the [Mission Climate Project](#). The Mission Climate Project draws on unique climate risk modelling³ to give stakeholders specific information about which climate impacts will be most severe, where and when. It also delivers guidance on what can be done to avoid, mitigate and adapt to these risks at local, national and international levels, preparing key decision-makers for climate impacts in the 2020s.

This document describes a three-and-a-half-year initiative that we are driving forward in the TM sector so that key decision-makers can make supply chains more resilient to climate risks. We started the project in June 2023, with this first phase running until at least the end 2026. But we are expecting to extend and expand the work thereafter. More on this to come.

We are already producing unique analyses (e.g. providing a climate lens to geopolitics, logistics and trade, and material risk at mine operations), convening powerful actors across supply chains (e.g. businesses, governments, industry and civil society organisations) and driving action at both local (e.g. community resilience pilots) and national / international levels (e.g. government advisory).

We are always looking for partners to improve our intelligence, to continue bringing together key actors and to put the data to work, to guide effective action strategies. If you are interested in contributing to or learning from this initiative, please contact minerals@asktmp.com for more information on how to engage.

1 We define EWE’s as unusual weather conditions triggered by significant changes in one or more climate indicators (e.g., changes in temperature and precipitation).

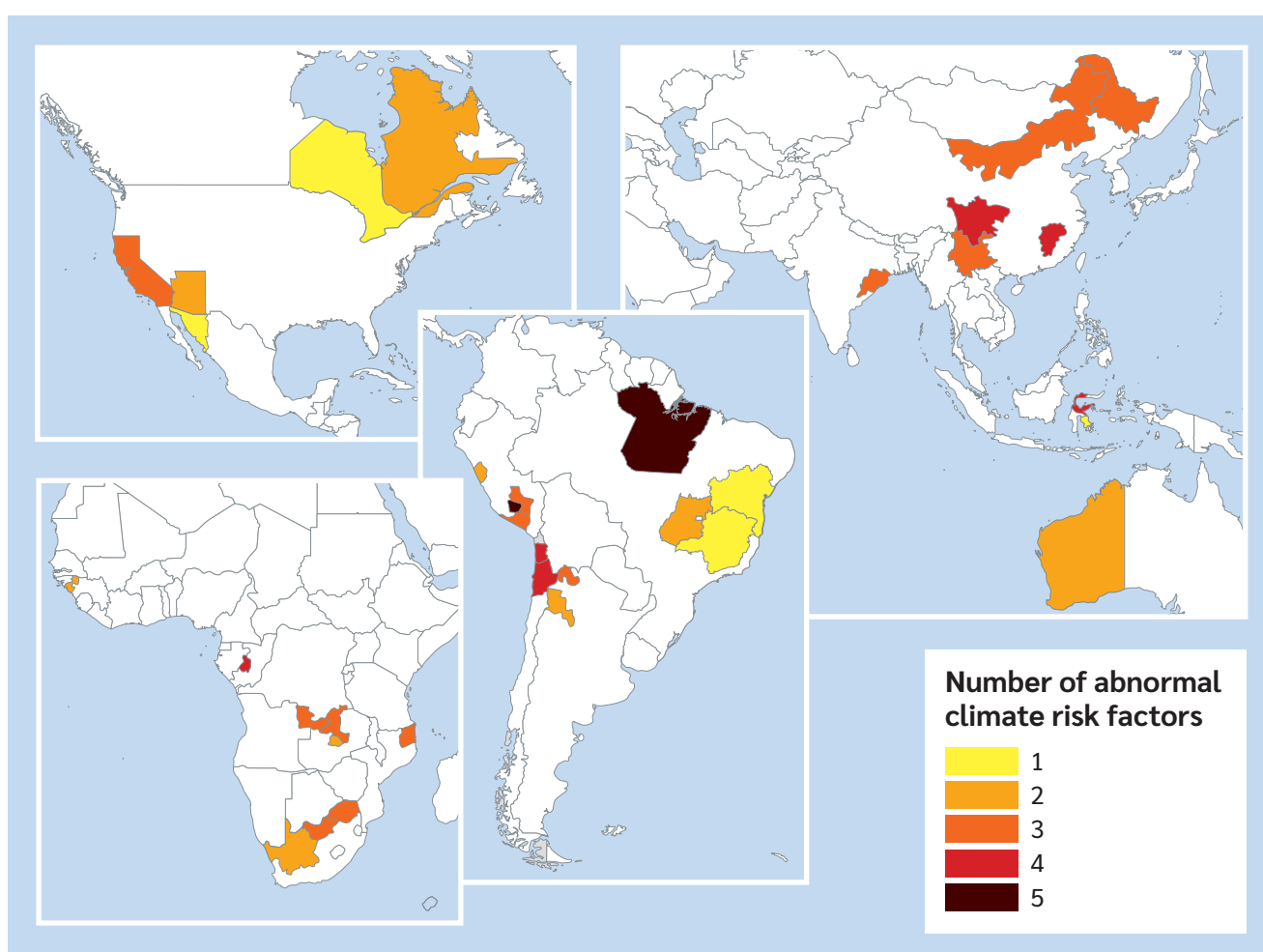
2 This includes materials like copper, lithium, nickel, cobalt, manganese, graphite, rare earths, aluminum and platinum.

3 Please get in touch if you would like to arrange a brief demonstration of our climate data.

How exposed are TM supply chains to climate risks?

Our analyses of TM supply chains are concerning. We surveyed 35 areas⁴ that account for a significant proportion of global TM production and processing⁵ and found that they are particularly exposed to EWEs in the next few years.

Specifically, 94% of the key areas are unusually exposed⁶ to imminent changes in temperature or precipitation patterns.⁷ We found that 46% of areas are extremely exposed to at least one EWE while 69% are unusually exposed to more than one EWE, making multihazard events a significant risk (see map below).



4 Areas are aggregated by Level 1 Administrative Districts, or the largest subnational administrative unit in a country e.g. a state in the United States or a province in China.

5 Cumulatively, these areas cover at least the following proportions of global production: Lithium (90%); Cobalt (71%); Mesh Flake Graphite (60%); Rare earth elements (55%); Manganese (44%); Nickel (40%); Copper (29%). They also cover a large proportion of mineral processing in China.

6 Any area above the 60th percentile is classified as “unusually exposed”; anything above the 80th percentile is “very exposed” and anything above the 90th percentile is “extremely exposed”.

7 We considered 8 climate variables including: increases in extreme temperature; unseasonably warm temperature; change in annual precipitation; change in annual dry days; unseasonably high rainfall; unseasonably low rainfall; change in consecutive dry days; change in consecutive wet days.

Crucially, EWEs will exacerbate existing social, political and environmental problems and so increase the threat of supply chain disruption. For example, we expect extreme temperatures to increase the likelihood of conflict and disputes in mining and processing areas, leading to long delays and project cancellations.⁸ Meanwhile, extreme rainfall will increase the risk of tailings pond failures like the Brumadhino disaster, and a lack of rainfall will aggravate local competition over access to water.

Our analysis of over 300 TM processing assets found that 43% were exposed to unseasonably high or low rainfall.⁹ In China, the world's largest TM processor by a considerable margin,¹⁰ exposure increased to 54% of assets, while most (75%) can expect extreme shifts in unseasonably low precipitation. Given China's reliance on water-dependent energy sources like hydro and thermal power, these results suggest that water scarcity could be a major constraint for Chinese processing.¹¹

We are not producing or sharing this analysis to scare people and the last thing we want is to inspire pessimism. But while there is typically recognition of climate risks amongst the experts, companies, investors and governments that we have spoken to, they also tend to underestimate the severity and material importance of climate change. This helps explain why decision-makers remain dangerously underprepared for near-term climate risks, and why we need to motivate responses that are proportional to the scale of the challenge. To achieve this, we need different decision-makers to build a shared picture of both the problem and its solutions.

Central to this approach is reliable near-term climate risk data and information. We use established climate datasets to provide high-resolution climate risk projections for the next 5-10 years. This unique near-term focus is complemented with a quantitative and qualitative understanding of local contextual conditions to better capture how physical climate impacts interact with the real world, enabling more actionable insights for decision-makers.

8 Links between increases in temperature and conflict are well-established: <https://esoc.princeton.edu/WP22> ; <https://web.stanford.edu/~mburke/papers/Burke%20Hsiang%20Miguel%202015.pdf>

9 We considered seasonal shifts in precipitation to anticipate challenges over water for processing inputs and for competition over water with other major users, like agriculture or energy production (e.g. hydropower and thermal coal) that is both reliant on a consistent supply of water and required for power-hungry processing facilities.

10 <https://www.iea.org/data-and-statistics/charts/share-of-top-three-producing-countries-in-processing-of-selected-minerals-2022>

11 Recent evidence supports these findings, with drought-induced hydropower shortfalls affecting the industry in Sichuan and Yunnan provinces: <https://www.fastmarkets.com/insights/power-rationing-china-battery-materials-sector-tightens-lithium-supply/> ; <https://www.reuters.com/article/idUSL4N36N1M4/>

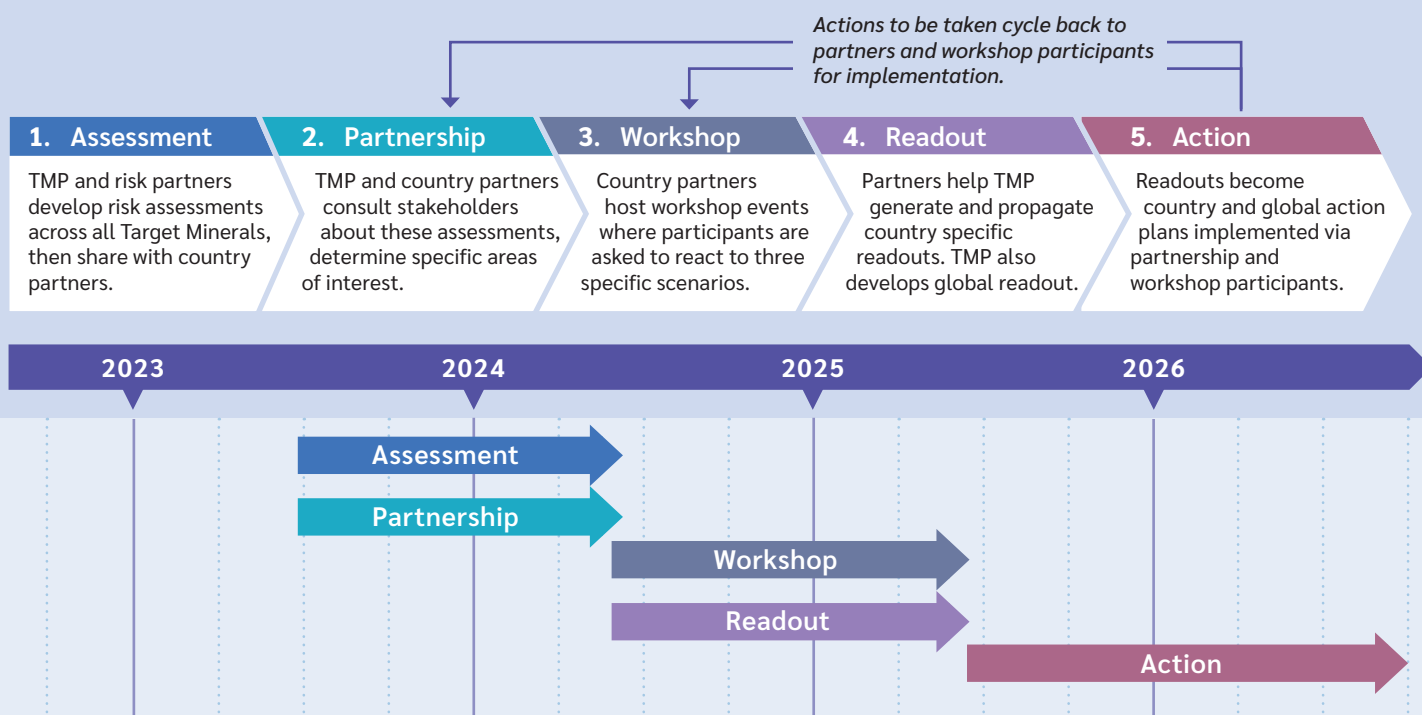
How will our work help?

TMP started this 3.5-year project – supported by the Hewlett Foundation and Quadrature Climate Foundation – to radically improve intelligence about, preparations for and actions that address cumulative climate risks. We are doing this by delivering persuasive information, enabling collaboration and catalysing responses. Our work will provide the glue that binds effective actors together around shared goals identified and calibrated through data and consultation.

The project supports global emissions reductions and reduces the risks of international conflict by ensuring that we have ongoing and expanded access to the raw materials that are needed for rapid decarbonisation this decade. At the same time, our project will improve the impact of mining and processing operations for local communities, countries and ecosystems.

Our scope is global, but we are focusing initially on 15 countries which are important producers, processors and consumers of TMs. In these geographies, we are using our unique information edge to catalyse meetings with key decision-makers to trigger actions that prepare for climate risks and their interactions with existing challenges.

Our project follows a partnership-driven, five-step process, where broadly the first year has been spent on the Assessments and Partnerships phases, the second year-and-a-half will focus on Workshops and Readouts and the final year on Actions.¹² In practice, we are sequencing this work in each target country and so there is considerable overlap between phases.



¹² The timelines provided in the five-step process graphic are indicative. In practice, we are sequencing each of the 15 countries so they are in different phases at any given time.

▶ 01. Assessments

We are developing reports, infographics, videos and other communication tools to communicate how climate risks and connected social, political, economic and/or environmental challenges could disrupt TM supply chains¹³. These assessments draw on state-of-the-art climate, social and hydrological modelling, alongside robust desk-top research and consultations to map exposure at country and global levels.

We are using these materials to raise awareness of cumulative climate risks and to encourage key decision-makers to implement the actions and policies that reduce their risk exposure (often by building the resilience of companies, local communities and ecosystems). Assessments are also used to develop plausible scenarios to support multi-stakeholder engagement processes intended to guide decision-maker responses to TM supply chain risks.

We have been producing analyses at various levels to engage different audiences, including national and jurisdictional insights for groups like governments, researchers and experts, and asset-level insights for industry and investors. These have included analysis of climate risks to logistics and trade routes for wind energy supply chains (e.g. copper and rare earths), and a quantification of the material impacts of extreme heat on physical worker capacity at mining operations, amongst others.

We are producing fresh analyses with 50+ climate indicators at our disposal. Our schedule of insightful new analyses includes a brief connecting Zambia's drought, debt and minerals growth; an analysis about the implications of China's weakening economy; flood and contamination risks in Indonesia, and more.

How you can benefit or engage

Please get in touch if you would like to learn more about our upcoming analyses. If you would like to either contribute to or provide feedback on these outputs and their value in decision-making processes, we would be interested to hear from you.

▶ 02. Partnerships

Partners are contributing to our analysis and supporting our efforts to convene powerful meetings which aim to foster concerted, significant action to address coming challenges. On the climate modelling side, we are working with [The University of Tokyo's Institute for Future Initiatives](#) to develop tailored climate risk algorithms, using established climate datasets (e.g. ERA5, CMIP6) to assess climate changes at highly granular spatial (e.g. 25x25km) and temporal (e.g. daily) scales.

We are also partnered with a host of powerful country-level and international convening partners (e.g., the [Atlantic Council](#), [Nikkei BP](#), [RUSI](#), [University of Melbourne](#), and [Fastmarkets](#), amongst others) to co-host a series of events and workshops informed by our modelling and analysis. Our "action partners" (e.g., [SOM](#), [Anglo American](#), [UC Davis](#) and [Japan's Ministry of Economy Trade and Industry \(METI\)](#)) are then supporting implementation and piloting of solutions that come out of preceding processes.

13 You can find our public-facing materials on our website: <https://asktmp.com/tms/>

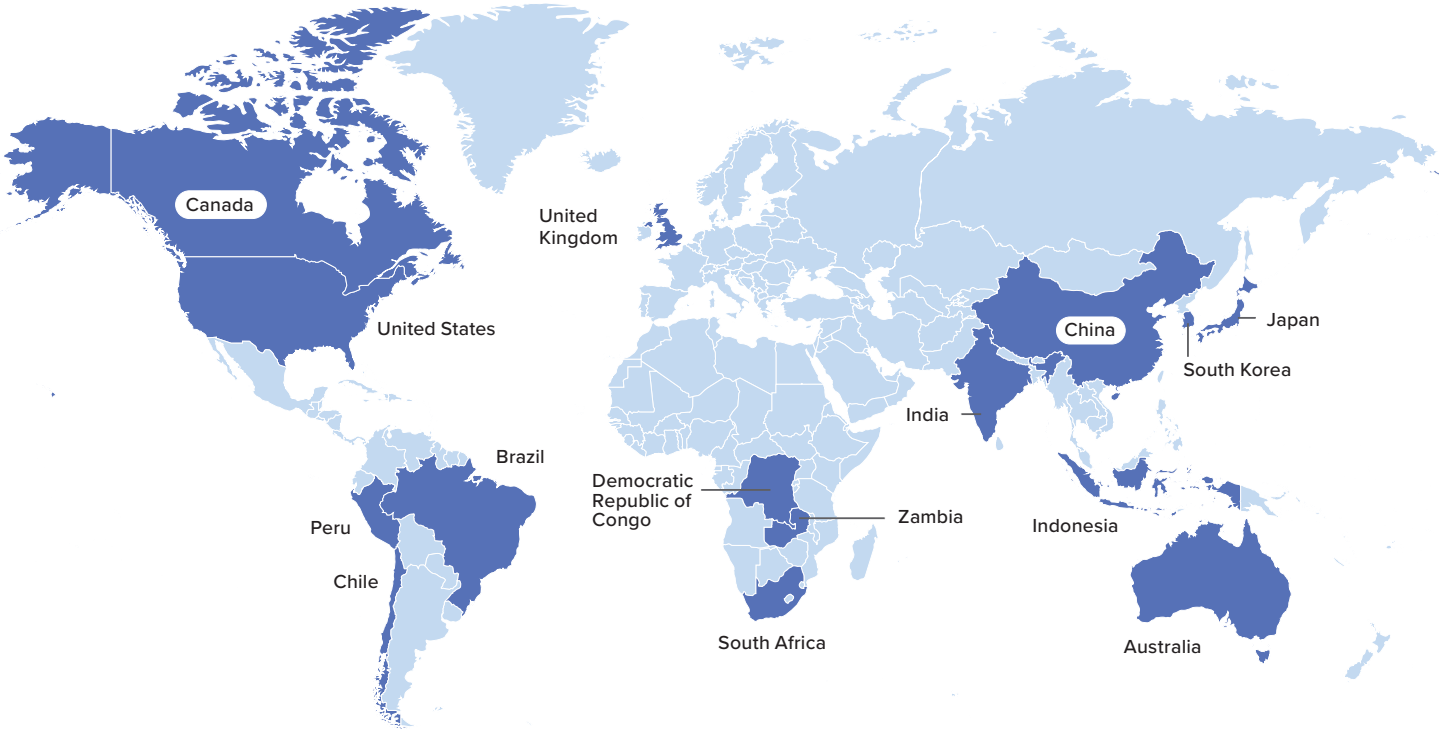
We are further supported by a wide set of knowledge partners and external experts from organizations like [Natural Resources Canada](#), [British Geological Survey / Critical Minerals Intelligence Centre](#), [Universidad de Chile](#) and [University of Technology Sydney](#) that we consult with about our plans, approaches and general thinking.

How you can benefit or engage

We continue to build a diverse coalition of organizations, experts and networks who help us to improve and communicate our unique intelligence. If you are interested in exploring a partnership, whether short and light or long and intensive, we would like to talk to you.

▶ 03. Workshops

Our 15 target countries are important producers, processors and consumers of TMs. The workshops and events in these countries aim to initiate pathways to action.



We have already co-hosted several successful events, including a larger awareness-raising event with Nikkei BP in Japan (June 2024), and two smaller workshops with RUSI in the UK (July 2024, January 2025). We developed strong relationships with government actors (amongst other groups) during these events and are now advising Japan’s METI and several UK Government Departments on risks and opportunities for their mineral supply chains (see more in Actions section).



TMP-Nikkei BP event (June 2024): “Business Responses to Climate Change: Risks and Responses for Critical Minerals”

We have a pipeline of events planned through 2025 (e.g. Chile event in May, US / Atlantic Council event in June, Indonesia / World Resources Institute event in June, Zambia / Impact Capital Africa event in July/August, South Africa in November)¹⁴. We are finalizing convening options in our remaining countries but have already secured convening partners in most of them. Our event focus, target participants and format will ultimately be decided in collaboration with our convening partners and through broader consultation processes in each country.

In addition to hosting / co-hosting our own events, we also participate in and speak at major existing events (e.g. Mining Indaba, PDAC Convention, Fastmarkets International Critical Minerals and Metals Summit) to engage different groups about our work.

How you can benefit or engage

Please reach out if you would like to help us to organize or co-host a workshop, meeting or larger event. We would be interested in hearing from you if you would like to attend one of our events or provide material for us to distribute to workshop participants. Similarly, please get in contact if you would like us to attend and/or speak at one of your events.

► 04. Readouts

The post-workshop period is focused on developing “readouts” – summaries of the workshops which capture key lessons from workshop discussions and any plans of action that were identified or agreed on as a result¹⁵. The readouts are fed back to any interested workshop participants and form the basis for defining roadmaps for improvement and actions that are aligned across stakeholder groups.

¹⁴ Please get in contact with us to find out more about our events.

¹⁵ For example, see the readout from our first UK event with RUSI (July 2024): https://drive.google.com/file/d/1o8ohb-2TuodU4hm1GPpLxW2hWvuy65T4x/view?usp=drive_link

Towards the end of the project, we will blend our country-level readouts to produce a global version. This will ensure that key lessons from country-level processes are shared and cross-pollinated, enabling globally aligned and locally appropriate actions that increase the resilience of TM supply chains.

How you can benefit or engage

Please get in contact if you would like to receive our readouts and/or provide feedback on them. If there are topics, pilot opportunities or networks that you think we should include in the Readouts, let us know.

► 05. Actions

The final phase of this work will create traction for a series of positive, urgent actions to address the risks and related issues that are highlighted in our assessments, discussed during the convenings and captured by the readouts. We are already scoping and have in some cases started piloting actions at different levels and in several key areas in the sector. We anticipate these actions to expand and mature over the remainder of the project:

- **Local adaptation and resilience pilots:** These include a community resilience pilot in the Salar de Atacama (Chile) with SQM and Nexo Territorial; an inter-faith dialogue and cooperation initiative with Forum Kerukunan Umat Beragama (FKUB) in South Sulawesi (Indonesia); and a pilot to improve agricultural livelihoods in mine-affected areas of Kalumbila (Zambia) with a local social enterprise.
- **Government advisory and support:** We are advising METI on the implementation of its battery subsidy strategy, where they plan to invest US\$44-191bn in international battery supply chains by 2030. We have also been helping UK government departments¹⁶ to better understand and manage systemic risks to the UK's mineral access. We are working to enable more effective engagement between multilateral governments as well, including via table-top exercises and multi-stakeholder forums.
- **Shared technical assistance facilities:** We are developing models for multistakeholder facilities that will operate at the subnational level (e.g. at jurisdictional or watershed-level). These facilities will pool resources and enable access to the expertise, intelligence, capital and training needed to deliver better outcomes for local communities and ecosystems by, for example, improving community engagement.
- **Sovereign debt support:** We are improving the quantification of near-term climate risks and their economic impacts to ensure they are factored into debt discussions for TM-producing and processing countries (e.g. Zambia). Mounting debt burdens restrict these countries' ability to invest in climate adaptation and so threaten the stability of TM supply chains. By providing better data and supporting debt relief efforts, we aim to help resource-rich countries build resilience to sustain the energy transition.

¹⁶ Including the Cabinet Office, the Department of Business and Trade (DBT), the Departments of Energy Security and Net-Zero (DESNEZ), the Ministry of Defence, the Foreign and Commonwealth Development Office (FCDO) and the Critical Minerals Intelligence Centre (CMIC).

- **Open-access asset-level minerals database:** Together with UC Davis, we are forming a consortium to develop a consolidated, open-access database that addresses known gaps in asset-level mining data. This initiative aims to improve supply and demand forecasting, enhance transparency on ESG and climate risks, and support improved research, investment and policy decisions by making critical data more accessible.

We think the above solutions can make a real difference, with further consultation and design. But we need routes to pilot and scale this set of responses and adaptation actions.

How you can benefit or engage

If you have an idea for a solution or would like to work with us on designing or implementing a solution that we have developed, we would like to be in contact. If you would like to learn more about any of the solutions briefly mentioned above, please reach out.

What next?

Thanks for taking the time to read through this brief. If you would like to learn more or get involved, please contact minerals@asktmp.com.

TMP is a relatively small organization, and we need help to achieve the ambitious aims and work program outlined in this note. We already have an extensive network of powerful partners and feel confident about the positive impact we can have together. But we are always interested in forming new partnerships with those who share our views on the challenges and potential solutions laid out in this document, while we certainly welcome the views of others on these important matters as well.

We have an exciting slate of events and analyses through 2025. We would like to hear from you if you are interested in collaborating on or participating in some of our events. Please also reach out if you are interested in understanding more about what our unique datasets and analyses we have to offer in this space.