British Geological Survey

GROWTH GATEWAY
GLOBAL PROSPERITY THROUGH TRADE & INVESTMENT

BRITISH GEOLOGICAL SURVEY

Responsible nickel roadmap for the Philippines

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Cover image Rehabilitated tailings storage facility (TSF 1) at Rio Tuba, Palawan. BGS © UKRI 2026

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Co-creating organisations

This roadmap was co-created with the input and support of the following organisations, which participated in meetings, workshops, site visits and follow-up discussions. They generously shared expertise, data and local knowledge and, in some cases, hosted site visits that informed our understanding of operational practice. Inclusion reflects participation in the process and does not imply endorsement of the report's content.

Asian Development Bank

Ateneo de Manila University

Boston Consulting Group

British Chamber of Commerce Philippines

Caraga State University

Chamber of Mines of the Philippines

Conservation International

Coral Bay Nickel Corporation

Department of Environment and Natural Resources (DENR)

DENR — Provincial Environment and Natural Resources Office of Palawan

Department of Energy

Department of Science and Technology (DOST) — Philippine Council for Industry, Energy, and Emerging Technology Research and Development (PCIEERD)

DOST — Philippine Nuclear Research Institute (PNRI)

Environmental Legal Assistance Centre

Environmental Management Bureau

Giolosts Technologies

Institute for the Development of Educational and Ecological Alternatives

Mines and Geosciences Bureau

Nagkakaisang mga Tribu ng Palawan (United Tribes of Palawan)

Nickel Asia Corporation

Office of the Special Assistant to the President for Investment and Economic Affairs

Palawan Council for Sustainable Development

Palawan NGO Network

Philippine Board of Investment

Philippine Mining & Exploration Association

Philippine Mining Development Corporation

Philippines Extractive Industries Transparency Initiative

Philippine Mining Club

Philippine Nickel Industry Association

Rio Tuba Nickel Mining Corporation

S&P Global Market Intelligence

SGS Philippines

Sumitomo Metal Mining

TVI Resource Development Philippines

University of the Philippines

- Department of Forest Biological Sciences
- Department of Mining, Metallurgical and Materials Engineering
- Institute of Human Rights
- National Institute of Geological Sciences
- National Institute of Molecular Biology and Biotechnology

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Tree planting activity at Tailings Storage Facility (TSF) 1, Coral Bay Nickel Corporation, Palawan. Reproduced with permission of Coral Bay Nickel Corporation.

Foreword

This report is the published product of a study by the British Geological Survey (BGS) funded by the UK's Foreign, Commonwealth & Development Office through the Growth Gateway programme. It draws on information from meetings, workshops and site visits in the Philippines in October and November 2025 and February 2026, plus a desk review. It represents one of the BGS deliverables for the Growth Gateway across several countries during the 2025 to 2026 financial year.

BGS is a non-departmental public body, part of UK Research and Innovation (UKRI). It is the UK's premier provider of geological data, information and knowledge to help address major global challenges. BGS works globally to support UK foreign policies and to help stakeholders make better decisions about geology and the role of geological processes in underpinning economy, environment and society.

Much of BGS's current international work focuses on the UK's Critical Minerals Strategy.

The contents of this report do not necessarily reflect the position of BGS or the British Government.

As part of the in-country visits, workshops were conducted with a range of diverse stakeholder groups alongside site visits, including Coral Bay Nickel Corporation and Rio Tuba Nickel Mining facilities. Hosting arrangements did not influence this report's content.

This roadmap consolidates perspectives gathered in the Philippines and is intended as an input to ongoing Philippine processes. It does not prescribe policy; rather, it reflects options stakeholders raised for consideration.

Acknowledgements

We gratefully acknowledge the organisations that supported the delivery of this work. In particular, we thank the British Embassy in Manila for supporting and facilitating this work.

We are grateful to Coral Bay Nickel Corporation (Sumitomo Metal Mining) and Rio Tuba Nickel Mining Corporation (Nickel Asia Corporation) for hosting us at their operations in Palawan, the insights of which were invaluable for this project. Hosting arrangements and access did not influence the analysis or findings of this report.

We also thank the BGS Graphics team for their expert assistance with formatting, report layout and graphics, as well as Nickel Asia Corporation and Coral Bay Nickel Corporation, which kindly provided photographs for use in this report.

Roadmap summary

Nickel is a strategically important metal for both traditional industries and the global clean energy transition. Global demand for nickel is rising rapidly as electrification and decarbonisation accelerate and the Philippines, which is the world's second-largest nickel producer, plays a pivotal role in meeting this demand. While most Philippine nickel is currently exported as unprocessed ore, the country aims to expand domestic processing, capture more value in-country and scale production responsibly to support sustainable development. Achieving these aims requires balancing industry growth with equitable benefit sharing for communities, environmental protection and long-term social and economic outcomes.

This roadmap was developed through workshops, meetings and site visits with Philippine stakeholders to help achieve this. It is forward looking, designed to complement existing initiatives and structured around the United Nations Resource Management System (UNRMS) principles, adapted to the Philippine context. The principles provide a framework for the integrated, sustainable and equitable management of natural resources in a standardised, systems-based way. The roadmap is intended to incentivise and support policymakers, industry, academia, civil society and other actors to undertake collaborative actions across governance, environmental management, social engagement, value addition, circularity, innovation, transparency and capacity building.

We hope that this roadmap will be adopted, adapted and implemented by Philippine stakeholders through coordinated action across government, industry and civil society. Anchored in the UNRMS principles, it provides a dynamic framework to help guide the Philippines toward a responsible, sustainable and globally competitive nickel industry.

A non-ordered summary of the Roadmap, structured according to the UNRMS principles, is given below:

1 State rights and responsibilities in the management of resources

- Establish long-term, coherent policy frameworks and align land-use planning with national strategies
- Streamline regulatory processes (digitisation; clearer timelines; longer-term processing permits) without weakening statutory safeguards
- Resolve overlapping or competing rights transparently
- Strengthen enforcement and integrity measures and protections for environmental and human-rights defenders
- Enhance state capacity and financing, including the potential for public-private partnership options
- Coordinate regional and international partnerships through a harmonised approach

2 Integrated management of resources

- Improve whole-of-government coordination, clarifying agency roles and responsibilities and aligning national-local implementation
- Strengthen national geoscience and integrated geospatial datasets linking mineral, land-use, social and environmental data in a central platform
- Integrate land-use planning, tenure systems and mine siting to reduce land-use overlaps
- Embed multi-hazard and climate risk management across the mine life cycle, from national frameworks to site-level system and including disaster risk reduction and climate change adaptation measures

3 Value addition

- Set a long-term industrial strategy and milestones
- Map nickel and nickel co-product supply chains
- Expand domestic processing through new facilities, technology partnerships and research and development
- Address logistics and power bottlenecks, including renewables and nuclear where appropriate
- Improve export valuation for ores and intermediates, including the value of chromium, cobalt, scandium and precious metals where present
- Capitalise on Development Finance Institution and green finance
- Apply transparent monitoring to any fiscal incentives
- If measures affecting directly shipped ore are implemented, phase them carefully alongside readiness assessments and support

4 Comprehensive resource recovery

- Strengthen analytical and laboratory capacity and advance deposit-scale mineralogical and geochemical characterisation to maximise recovery of economically significant trace or minor metals (chromium; cobalt; scandium) and, where feasible, platinum group metals and rare earth elements
- Evaluate the integration of carbon dioxide (CO_2) mineralisation within ore processing flowsheets to reduce emissions and stabilise waste, subject to safeguards and feasibility

5 Circularity

- Advance utilisation of waste and tailings through national-scale resource assessments, standards and specifications for construction and industrial uses, and material-flow analyses mapping ore-to-product-to-residue
- Pursue rehabilitation-linked approaches (for example, nickel hyperaccumulators and phytomining)
- Progress research and development on re-purposing options such as ceramic products, asphalt blends and magnetite adsorbents for water remediation

6 Innovation

- Strengthen digital tools (machine learning-enabled prospectivity; cloud geospatial platforms)
- Accelerate research and adoption of lower-impact mining and processing (for example, phytomining; benign solvents; CO_2-integrated processing flowsheets; tailings recovery)
- Expand real-time environmental monitoring (water; air; soil), Earth observation and remote sensing for hazards and tailings storage facilities
- Incentivise waste-to-value and nature-based rehabilitation
- Build research-to-commercialisation pipelines via coordinated mechanisms, long-term funding and pilot or demonstration facilities

7 Responsibility to the planet

- Assess alignment with international environmental, social and governance standards
- Improve baseline biodiversity and hydrology datasets
- Apply catchment-scale assessment of cumulative impacts
- Reduce greenhouse gas emissions via renewables and integrate life cycle assessment into planning and operations
- Implement strong water stewardship with transparent monitoring
- Continue upholding robust environmental safeguards
- Adopt nature-positive rehabilitation standards with mitigation hierarchy, native-species restoration, outcome-based metrics and emerging remediation technologies, while also considering alternative, beneficial post-mining land uses

8 Social engagement

- Deepen participatory, transparent community engagement and benefit-sharing
- Reinforce free, prior and informed consent and engagement with Indigenous Peoples via independent advisory support and safeguarding procedures, equitable benefit sharing and knowledge-sharing pathways
- Expand education, outreach and gender-inclusive policies
- Strengthen social safeguards and dispute resolution mechanisms
- Develop community transition and legacy plans that link social and environmental closure

9 Transparency

- Increase the availability and interoperability of standardised baseline and geospatial data
- Progress project-level disclosure
- Create best-practice libraries for rehabilitation and restoration
- Enhance disclosure and community-facing reporting across the mine life cycle
- Strengthen community-facing reporting and data tools
- Explore stakeholder-driven reward systems for transparency
- Strengthen multi-partite monitoring teams (diverse participation; accessible reporting)

10 Health and safety

- Maintain and enhance health and safety standards including baseline and seasonal air-quality monitoring around sites and downwind communities
- Give guidance on and protection from exposure to naturally occurring asbestos[1] in laterites
- Expand dust suppression
- Provide ongoing medical surveillance for workers and local populations

11 Continuous strengthening of core competencies and capabilities

- Invest in education and advocacy
- Deliver cross-disciplinary workforce training (technical; social; regulatory)
- Strengthen institutional capacity through continuing professional development for regulators
- Establish centres of excellence linking universities and industry (pilot plants; internships; skills development)
- Expand analytical and laboratory infrastructure for geochemistry and metallurgical test work
- Promote long-term collaborations and knowledge exchange across the sector

[1] Asbestos minerals found naturally in rock and soil.

Cityscape of Manila, Philippines. BGS © UKRI 2026.

Introduction

Nickel is a strategically important metal for both traditional industry and the global clean energy transition. It is widely used in stainless steel and high-performance alloys, underpinning construction, infrastructure and manufacturing. Nickel is also a critical input to lithium-ion batteries used in electric vehicles and energy storage, where it improves energy density and performance. As electrification and decarbonisation accelerate, global demand for nickel from energy transition technologies is expected to grow rapidly, increasing its economic and strategic significance (IEA, 2025).

The Philippines is a significant mining nation and the world's second-largest producer of nickel ore after Indonesia, although most is exported as unprocessed ore to China and, increasingly, Indonesia. The Philippine government aims to capture more of the value chain by growing its nickel industry in a responsible and sustainable manner, in line with the needs and rights of the Philippine people, by developing its downstream processing capacity. However, challenges include energy costs, infrastructure constraints, existing processing capacity, regulatory complexity, natural hazards and environmental and social performance. Recent reforms and initiatives represent substantial progress, but stakeholders noted that several are relatively recent and their full effects may not yet be evident at the project and community levels.

This roadmap aims to support the responsible and sustainable growth of the nickel industry in the Philippines. It has been written by the British Geological Survey (BGS) and its development was led by Philippine stakeholders. It aims to set out clear steps to advance the sustainable development of the Philippine nickel industry. It builds on a previous project investigating the environmental, social and governance (ESG) aspects of critical mineral mining in the Philippines. This roadmap was designed on the basis of previous work and associated discussions with Philippine stakeholders.

BGS teams visited the Philippines in October and November 2025 and February 2026. The first trip included a site visit to the Coral Bay Nickel Corporation's processing facility and the associated Rio Tuba Nickel Mining Corporation's laterite mine in Palawan, followed by stakeholder workshops in Puerto Princesa and Manila. The workshops aimed to identify sector strengths and challenges and to co-develop practical actions for a responsible nickel value chain. Sessions used a 'Political, economic, social, technological, legal and environmental' or PESTLE exercise to guide the identification of strengths and challenges, then prioritise actions. While stakeholders were encouraged to consider the strengths and challenges of the sector in each category of the PESTLE framework, these were considered holistically and several strengths and challenges were noted to fall at the intersection of multiple categories.

Notes were digitised and mapped to United Nations Resource Management System (UNRMS) principles to develop this report. Follow-up meetings with stakeholders in February 2026 were used to validate findings and refine recommendations. Further details on objectives, methods and attendees are provided in Appendix 1.

While this roadmap draws on existing published literature, it is primarily based on inputs from Philippine stakeholders during the workshops. As far as possible, it reflects views across the Philippine nickel industry and related stakeholders, although it was only possible to visit one of the nine provinces where nickel mining operations are currently active. We recognise that local governments, academia, industry and local and Indigenous Cultural Communities in each of these regions have distinct experiences and views. Furthermore, this report is not intended to be an extensive review of the current situation but rather be forward-looking.

It is acknowledged that this will not form the definitive roadmap for the Philippine nickel industry but will form part of a wider strategy-forming process. This roadmap is intended to complement, rather than duplicate, existing frameworks and roadmaps and is to be taken forward and implemented by Philippine stakeholders. Implementation decisions, including the selection, timing and resourcing of actions, are for Philippine stakeholders to determine and are therefore not prescribed in this report.

The roadmap is structured around UNRMS (UNECE, 2021, 2022). UNRMS is a resource management system that focuses on having a comprehensive approach to resource management across the value chain with sustainability and ESG at its core (Bide et al., 2021; UNECE, 2021, 2022).

UNRMS is considered a useful tool for governments to manage their natural resources in a responsible manner for the benefit of a nation's prosperity, its people and the environment (Bide et al., 2021). While the practical application of UNRMS is still in development, a recent case study applying UNRMS in Cornwall, UK proved the system can help assess and guide the development of mineral resources (Marquis et al., 2024). The system follows twelve fundamental principles (Figure 1), eleven of which have been adopted here as the guiding principles of the roadmap and provide its structure. The principle of 'Service orientation' was excluded, as its objectives were considered sufficiently addressed by the other principles. For some principles, the wording has been adjusted to ensure clearer alignment with the objectives and scope of the roadmap in the Philippine context. The principles have also been re-ordered from the original UNRMS presentation to better align with the thematic areas of the roadmap; this re-ordering does not imply relative importance or establish a hierarchy among the principles. A full overview of the UNRMS principles is provided in Appendix 2. This work also provides an opportunity to test the practical application of the UNRMS framework, contributing to wider global learning about how UNRMS can be implemented.

Not all the action areas in the roadmap are novel; some re-emphasise the importance of existing initiatives or suggest modifications to current good practice. Naturally, there is overlap between the UNRMS principles and actions have been placed where they are deemed to best fit. However, none of the issues or actions raised here should be considered in isolation; they should be addressed as part of a comprehensive, holistic approach to resource management, consistent with the UNRMS approach.

Figure 1 The eleven principles of the United Nations Resource Management System (UNRMS), after UNECE 2022, that have been adapted for the roadmap.

Nickel value chain

Nickel is sourced globally from two main deposit types: sulfides and laterites. With the global decline in high-grade sulfide ores, the global nickel industry has shifted to utilising and advancing processing technologies for lower-grade bulk tonnage nickel laterite deposits (Mudd, 2010). The key operational distinction within the laterites is between limonite and saprolite ores (further discussed in Section 3), which follow different processing routes and produce different market products. Limonite ores are processed through hydrometallurgical methods (for example, high-pressure acid leaching (HPAL)), resulting in intermediates (such as mixed sulfide precipitate and mixed hydroxide precipitate) and further refined products such as nickel sulfate and nickel oxide (Dalvi et al., 2004). These products supply the Class 1 nickel value chain (over 99.8 per cent purity) used in batteries and speciality alloys. Conversely, saprolite ores require energy-extensive pyrometallurgical methods (for example, smelting) (Dalvi et al., 2004) to produce ferronickel or nickel pig iron that feeds primarily into the Class 2 nickel value chain (less than 99.8 per cent purity), which is predominantly consumed by stainless steel production (Saegert et al., 2022). Figure 2 summarises these processing pathways within the

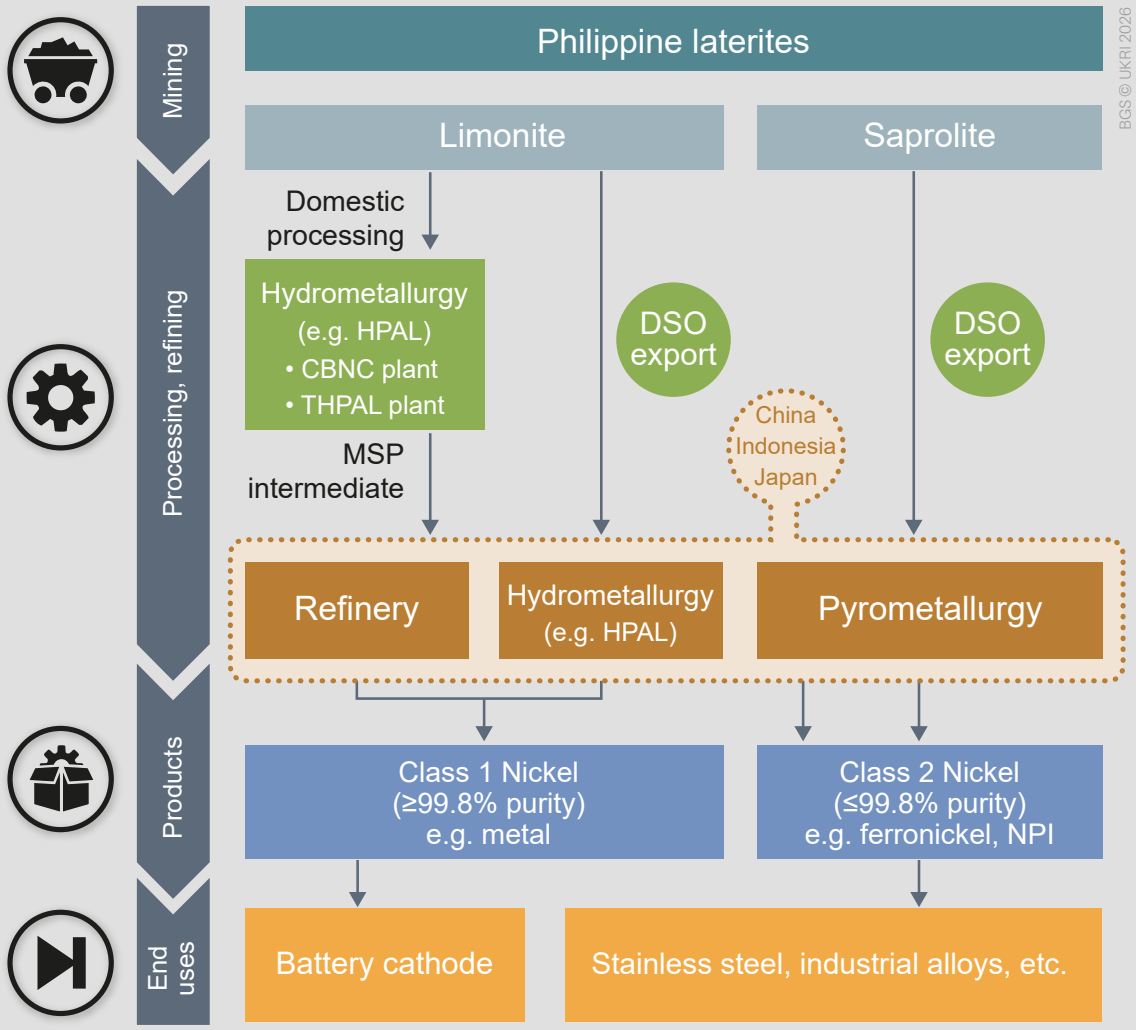

Figure 2 Philippine nickel value chain showing the pathways for limonite and saprolite ores from mining through processing, refining and end-use applications. Modified from IEA (2021) and SMM (n.d.). HPAL – high-pressure acid leaching, CBNC – Coral Bay Nickel Corporation, THPAL – Taganito HPAL Corporation, DSO – direct shipping ore, MSP – mixed sulfide precipitate, NPI – nickel pig iron.

Philippine nickel value chain, which is discussed further in the next section.

Laterite processing, particularly through HPAL, also generates several critical by-products. Cobalt is the most common co-product, with some HPAL processing flowsheets additionally designed to recover chromium, scandium and iron (Fe)-rich residues with potential for further valorisation (Amador et al., 2025). These co- and by-products have the potential to enhance the economic and strategic importance of laterite operations.

Because processing pathways require substantial processing capacity, the countries that dominate mining output are not always the same as those that dominate refining:

- Indonesia and the Philippines remain the world's largest producers of laterite-derived nickel ore
- China has been the largest nickel ore consumer, accounting for around 60 per cent of global nickel demand between 2020 and 2024, driven primarily by stainless steel production and its growing battery sector
- Indonesia is the second largest ore consumer, representing roughly 5 per cent of demand in 2024 (IEA, 2025)

In terms of refined nickel production, Indonesia's rapid downstream build-out means the IEA projects that, by 2030, Indonesia will replace China and supply 45 per cent of global refined nickel, followed by China at 33 per cent and Russia at 3 per cent (IEA, 2025).

Rehabilitated Tailings Storage Facility (TSF) 1, Coral Bay Nickel Corporation, Palawan. Reproduced with permission from Coral Bay Nickel Corporation.

Overview of the Philippine nickel industry

Geological, geographical and historical context

The Philippines sits at the convergence of several tectonic boundaries (Figure 3), giving rise to one of the most complex geological environments in South-east Asia. This dynamic tectonic regime generates volcanism and creates potential for large earthquakes that can trigger landslides and accounts for the ancient, uplifted fragments of ocean-floor rocks (ophiolites) onto land. The ophiolites, prominently exposed in Zambales (Luzon), Palawan and the Surigao district (Mindanao), are vital in the formation of the country's nickel deposits.

Nickel in the Philippines is mined from nickel laterites, which are surface deposits mostly found in tropical to subtropical regions and tectonically active collision zones (for example, the Philippines, Indonesia and New Caledonia) where ophiolite rocks are subjected to long-term, intense weathering (Elias, 2002). Ophiolite rocks, specifically their ultramafic constituents, naturally contain nickel bound within magnesium-rich silicates. As rainwater infiltrates the rock, it starts to break down and dissolve the original minerals. Over long timescales, this results in the formation of a vertically zoned laterite profile enriched in nickel, with each zone representing different degrees of weathering or alteration (Elias, 2002). Nickel laterite profiles range from a few metres to over 100 m in depth (Marsh et al., 2013) and are typically characterised by the original ultramafic rock (often termed bedrock) overlain firstly by a saprolite zone, then a topmost limonite zone.

The rocky saprolite layer reflects the early stages of weathering and is composed of secondary silicate minerals (for example, serpentine; chlorite; talc). Overlying the saprolite zone is the highly weathered iron (oxyhydr)oxide-rich (for example, goethite; hematite) horizon where the original rock fabric has been lost due to intense weathering and mineral transformation reactions (Elias, 2002; Golightly et al., 2010).

While the tropical climate of the Philippines has been conducive for the formation of nickel laterites, it also means the country is vulnerable to hydrometeorological hazards (for example, tropical cyclones; flooding; drought) and the effects of climate change. The vulnerability of the Philippines to hydrometeorological and geological hazards places the country among those with the highest assessed disaster risk globally, according to the World Bank's World Risk Report for the last four years (2022 to 2025) (Atwii et al., 2022; Frege et al., 2023, 2024, 2025). Combined with the country's tectonic activity, this creates an operational context where mining practices must be evaluated not only for geological suitability but also for resilience to natural hazards alongside conventional considerations, such as environmental and social performance.

Interest in Philippine nickel laterites began in the early 1900s, with brief mining occurring at Nonoc, Surigao del Norte, for Japanese refineries during World War II. Exploration expanded in the 1950s, while large-scale operations emerged in the 1970s with key mines such as Rio Tuba (Palawan) and Hinatuan (Surigao) that largely supplied the Japanese refinery market. Nickel processing in the Philippines began in 1974 in Nonoc. This capacity briefly positioned the country among the world's notable refined nickel producers, ranking 10th globally in 1981, although the operations halted in 1986 due to operational issues. Later, the Philippine Mining Act of 1995 allowed large-scale, foreign-owned mining, established a permitting system to streamline the entry of investors and expanded the coverage of mining activities, leading to an expansion of the mining industry (MGB, 2004).

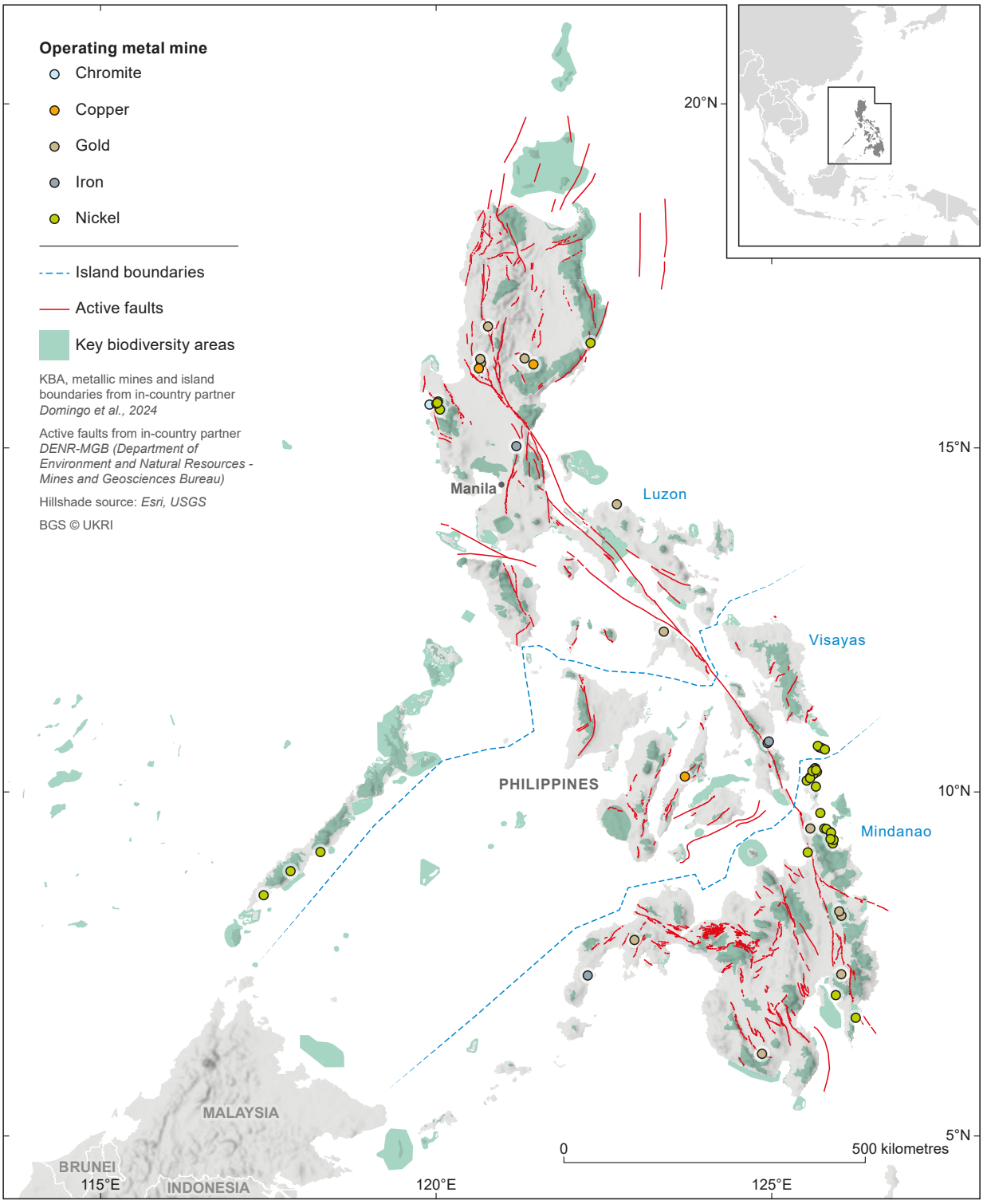

Figure 3 Map of the Philippines showing current operating mines in relation to major tectonic systems and biodiversity areas. Reproduced with permission from Domingo et al., 2024.

The Philippines as a nickel hotspot

The Philippines is one of the world's most significant nickel sources, ranking sixth globally in reserves (approx. 3.7 per cent of world total) and second to Indonesia in world mine production (11 per cent of world total) (Figure 4) (Idoine et al., 2025; USGS, 2025). With 39 operating nickel mines out of 61 operations working metallic minerals nationwide (MGB, 2026), the sector continues to underpin the country's mineral output (Figure 5). In 2023, nickel ore and its by-products (nickel/cobalt mixed sulfide; scandium oxalate) represented the biggest share and almost half (47.6 per cent) of the metallic mineral production in the country by value, at 89.99 billion Philippine pesos (₱) (approx. US$1.62 billion) (MGB, 2023). By 2024, it reached an estimated ₱94.23 billion (approx. US$1.64 billion) in production value (MGB, 2024). However, the current overall contribution of the mining industry to the country's gross domestic product share remains modest (0.74 per cent) (MGB, 2026), reflecting limited value addition and persistent dependence on direct shipping ore (DSO) exports.

In 2025, Philippine metallic mineral production value rose 18.2 per cent to ₱301.32 billion (approx. US$5.24 billion), largely due to stronger gold and nickel prices. Gold remained the top contributor; nickel DSO output rose 5.6 per cent to 37.81 million dry metric tonnes (DMT), while its value jumped 18.1 per cent to ₱69.36 billion (approx. US$1.21 billion), reflecting improved market prices. Nickel/cobalt mixed sulfide production rose 6.8 per cent to 76 666 DMT, although its value edged down 1.6 per cent to ₱36.79 billion (approx. US$617 million). Scandium oxalate production plunged 56.4 per cent, while its value declined 55.8 per cent to ₱86.08 million (approx. US$1.5 million) (Galvez, 2026). It is also noted that the economic contribution of mining varies by region, in relation to the distribution of nickel resources and operations.

As of 2018, identified nickel laterite mineral resources included 34 deposits containing a total of 18.87 megatonnes (Mt) nickel at 1.16 per cent nickel, and seven deposits containing 4.41 Mt nickel at 1.15 per cent nickel. For context, cumulative national nickel production was 5.72 Mt by 2023 (data updated from Mudd and Jowitt, 2022), suggesting potential for further growth in production and underscoring the country's long-term supply potential.

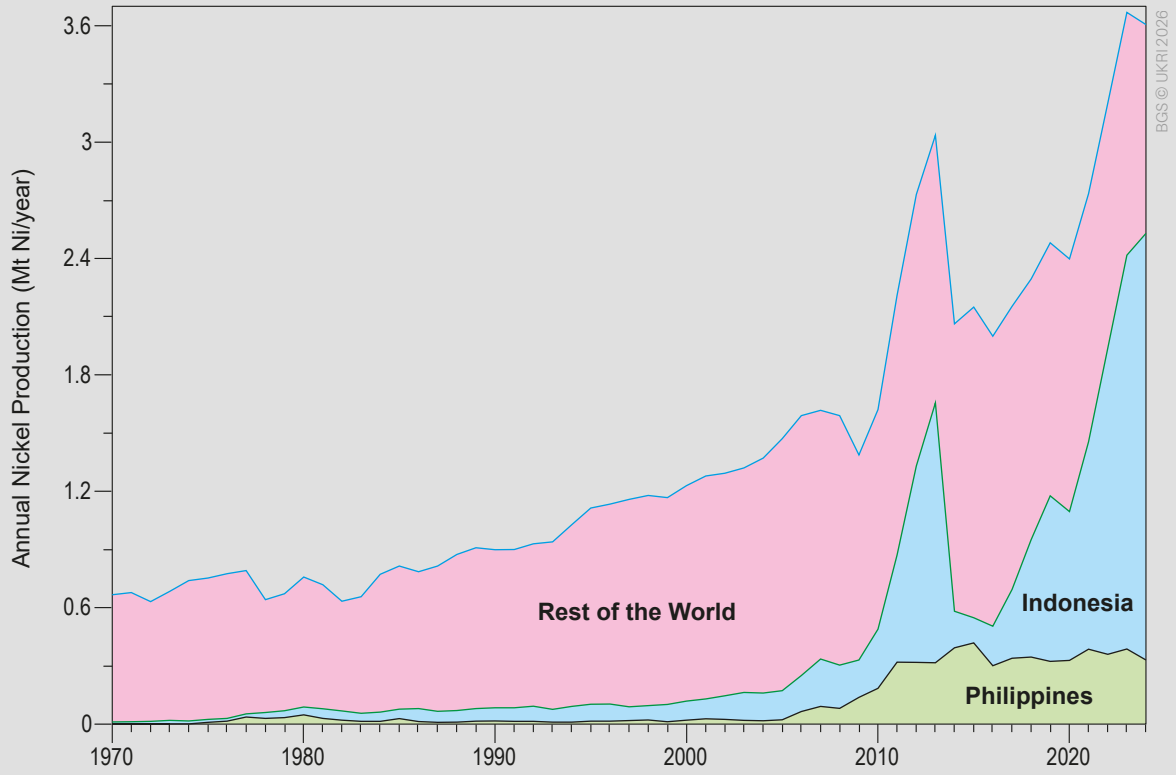

Figure 4 World nickel production over the last 50 years, highlighting the Philippines and Indonesia. Data from Idoine et al 2025.

Despite this resource wealth, the industry is still largely upstream-oriented, dominated by the direct shipment of ore to other countries (Figure 2). While DSO has underpinned employment and local revenues for two decades, stakeholders identified opportunities to progressively increase in-country value addition (where commercially and environmentally viable). While two forms of nickel laterite ores, limonite and saprolite, give the Philippines theoretical access to both Class 1 (over 99.8 per cent purity; for electric vehicle batteries) and Class 2 (less than 99.8 per cent purity; for stainless steel) nickel value chains, domestic midstream capacity is limited to two plants processing the low-grade limonite ores: Coral Bay Nickel Corporation (CBNC) in Palawan (planned for closure in 2028) and Taganito HPAL Nickel Corporation (THPAL) in Surigao. Both operations are subsidiaries of Sumitomo Metal Mining Co., Ltd. and use HPAL technology to produce a mixed nickel/cobalt sulfide intermediate product that is exported and refined in Japan (Shibayama et al., 2016). THPAL has also expanded into recovering chromium and scandium in the form of an oxalate concentrate (Amador et al., 2025), making the Philippines and its nickel laterite deposits also an important source of scandium (USGS, 2025).

The Philippines operates two processing plants and, with CBNC scheduled to cease operations in 2028, the sector remains dominated by DSO. Under the DSO model, co- and by-products (for example, chromium; cobalt; scandium) are effectively ignored in ore pricing. While this limits domestic value addition, it also reduces the volume of nickel mine wastes or tailings generated, as well as energy use and associated emissions. In 2024, national mine output declined by about 20 per cent as companies scaled back or suspended operations amid weakening nickel prices and the rise of Indonesian supply, which added further downward pressure to the market (USGS, 2025). Any future expansion of domestic processing therefore presents trade-offs and risks that will require careful planning and responsible implementation to avoid increasing environmental and emissions impacts.

Historically, more than 90 per cent of Philippine DSO shipments have gone to China (Figure 6). In 2023 to 2024, however, rapid smelter expansion in Indonesia and production control measures started to create ore shortages and alter trade flows (PCIEERD, 2024). Shipments of nickel ore from the Philippines to Indonesia increased, with total shipments to Indonesia in 2025 standing at around 15 Mt (Serapio

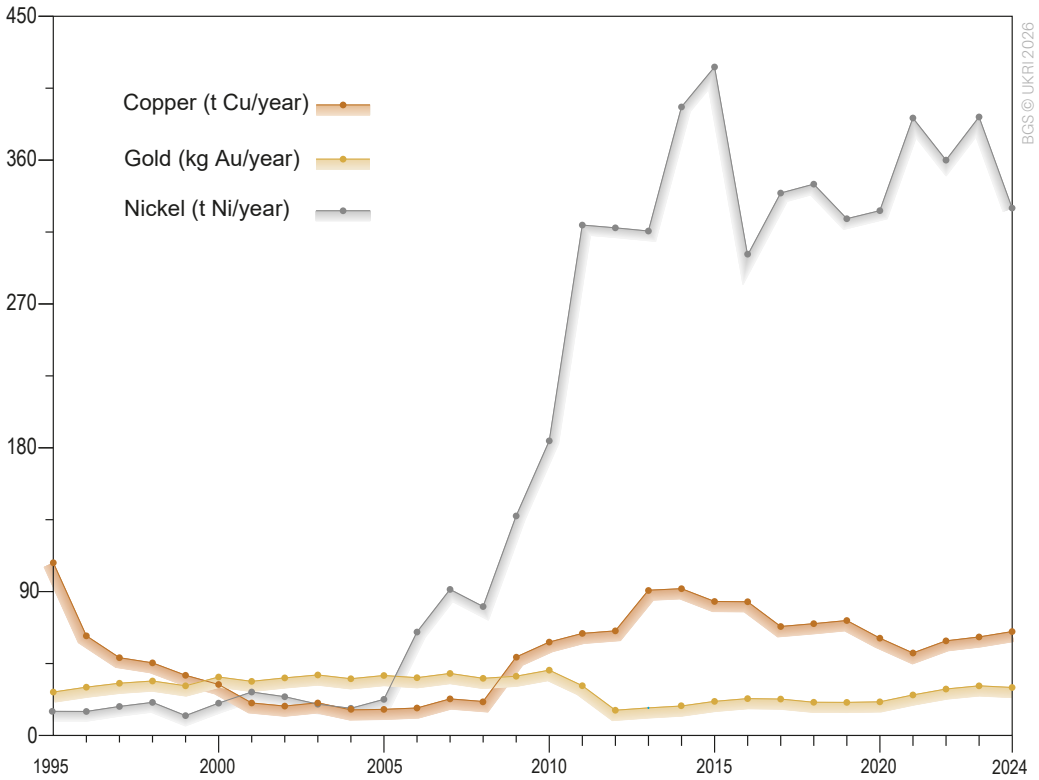

Figure 5 Philippine mine production of copper, gold and nickel over the last 30 years.

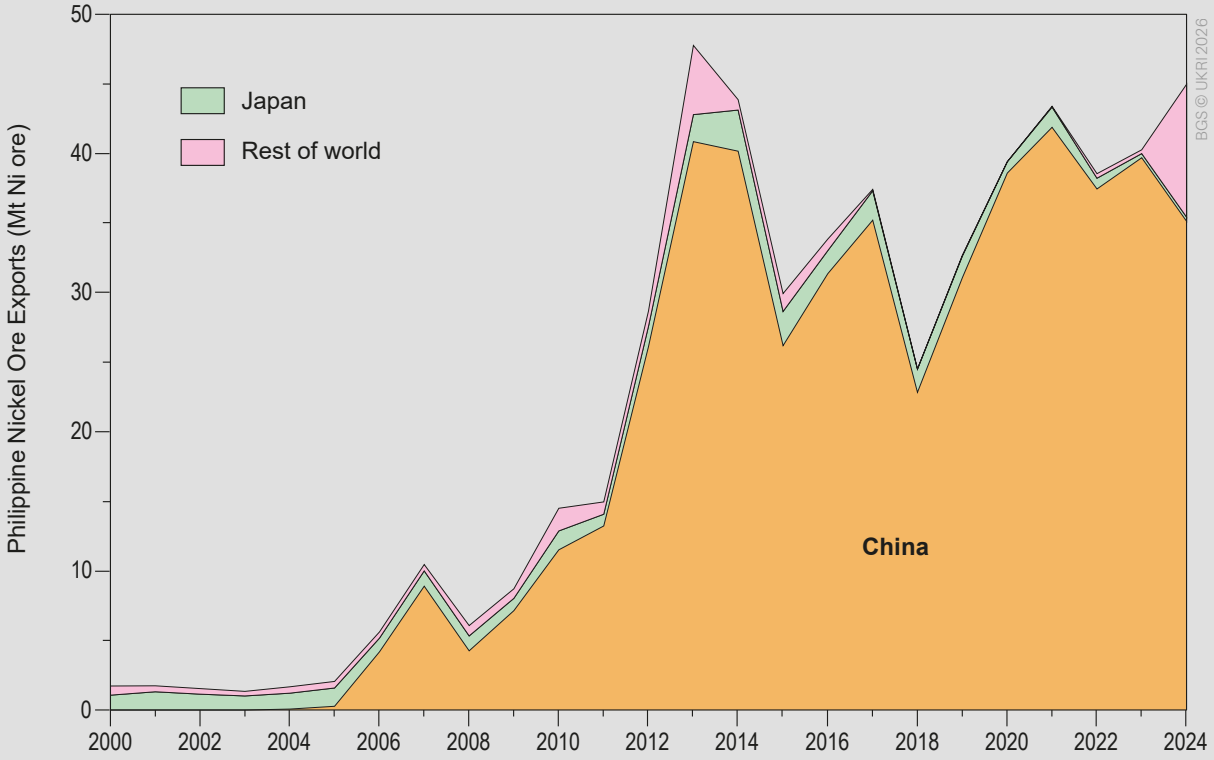

Figure 6 The destination of direct nickel laterite ore exports from the Philippines, highlighting the role of China. The rise in 'Rest of the World' from 2023 is due to growth in Philippine exports to Indonesia. Data from the United Nations Department of Economic and Social Affairs (2024).

Jr and Venzon, 2026). This reflects a redirection in destination rather than an increase in total Philippine production.

Globally, nickel prices have been volatile, undermining industry stability and deterring investment. Global supply rose by about 10 per cent between 2023 and 2024 (from 3.6 to 3.9 Mt), growth was concentrated in Indonesia, which increased output by about 25 per cent. This was offset by declines in New Caledonia, Australia, Canada and the Philippines (IEA, 2025). Despite recent weakness, the Philippines features prominently in long-term supply scenarios: in the IEA's outlook, it provides the largest additional mined supply in the 'high production case' by 2035, though it does not feature strongly in forecasts for refining-sector diversification (IEA, 2025).

Challenges and outlook

The Philippines benefits from a strong legal foundation and several examples of good practice:

- the Philippine Mining Act (1995) and related regulations are widely regarded as robust
- the Resource Governance Index rates the regulatory environment as 'good'
- the country is an Extractive Industries Transparency Initiative (EITI) member with multiple national reports
- listed companies are required to publish sustainability reports
- adoption of Towards Sustainable Mining (TSM) by the Chamber of Mines

The environmental approvals regime is governed by the Philippine Environmental Impact Statement System under Presidential Decree No. 1586. Prior to commencing development or operation, mining projects must complete the Environmental Impact Assessment (EIA) process and secure an 'Environmental Compliance Certificate' (ECC). An ECC stipulates binding compliance and monitoring conditions for the life of the project. 'Environmental protection and enhancement programmes' (EPEPs) and 'Final mine rehabilitation or decommissioning plans' (FMRDPs) operate within this framework to ensure ECC conditions are met, particularly around progressive rehabilitation, environmental management and proper mine closure. Recent

measures, such as Department of Environment and Natural Resources (DENR) AO 2022-04 on biodiversity monitoring and the Philippines Ecosystem and Natural Capital Accounting System (PENCAS) Act (2024), further embed natural-capital accounting into decision making. However, stakeholders noted that challenges remain, including implementation, value addition, dispute resolution and complex and lengthy permitting processes, although meaningful progress in streamlining and improving the permitting process has been made in recent years.

Environmental performance in the Philippine nickel sector shows both progress and gaps. There is strong legislation with examples of successful rehabilitation, regular Multi-partite Monitoring Team (MMT)-led monitoring and improving standards; however, workshop participants and prior studies raised concerns around:

- biodiversity loss
- catchment impacts
- pollution
- greenhouse gas (GHG) emissions
- limitations in baseline data
- effectiveness of current monitoring and compliance structures

Mining companies are subject to a range of strong environmental regulations and licensing requirements, including EPEPs and FMRDPs, alongside routine monitoring by MMTs. Issues around implementation were highlighted, however, such as the example of 'temporary greening', whereby short-term re-vegetation is used to meet cover metrics without restoring native ecosystems or long-term ecological function.

On social performance, the Philippines is one of the few countries to enshrine free, prior and informed consent (FPIC) in law. Mandated Social Development and Management Programme (SDMP) investments have delivered visible local benefits notably in education, health and infrastructure. Nonetheless, public scepticism persists and the FPIC process is reportedly complex and inconsistently implemented.

Stakeholders emphasised making benefit-sharing arrangements clearer and more equitable, sourcing independent legal and technical advisory support for Indigenous Peoples and strengthening neutral, multi-level dispute resolution pathways. Mine-closure planning and social legacy require particular attention: despite a structured closure funding framework, communities often face uncertainty around post-closure livelihoods, continuity of SDMP-type benefits and long-term monitoring of environmental and cultural impacts.

As highlighted previously, the sector's economic position is also shaped by its heavy reliance on DSO. This limits domestic value addition, constrains opportunities for co-product recovery (chromium; cobalt; iron; scandium) and exposes operations to volatile nickel prices and policy shifts. Enhancing competitiveness will require diversifying and expanding downstream processing. As interlocking challenges to downstream expansion beyond price volatility, stakeholders pointed to:

- high energy costs
- infrastructure and logistics bottlenecks
- multi-hazard exposure
- permitting complexity
- data and transparency gaps
- skills and laboratory capacity needs
- uneven implementation

Taken together, the sector combines real strengths (legal frameworks; transparency initiatives; established monitoring; targeted compensation; rehabilitation experience) with challenges. Building on this, Section 4 outlines the vision for the sector, which provides the guiding direction for the roadmap and frames the action areas aligned with UNRMS principles.

To provide context for the roadmap, key features of the Philippines nickel sector are outlined against the principles of UNRMS (Table 1). The information in Table 1 is derived from the stakeholder workshops using a methodology known as PESTLE analysis (Appendix 1).

Table 1 Summary table of Philippine nickel industry strengths and challenges mapped to the UNRMS principles. The contents of this table are based on a PESTLE analysis conducted in stakeholder workshops. The table reflects the views as expressed by a range of stakeholders from across government, industry, academia and civil society as closely as possible. The table is not intended to be comprehensive or exhaustive.

UNRMS principle	Strengths	Challenges
State rights and responsibilities in the	• Government support for the mining sector • Regional and international partnerships • 'Green lane' for strategic investments • Strong mining law and ESG standards • Updating of national databases and exploration data for nickel • Mining fiscal tax regime (MFTR): minimum setting of revenue sharing • New frameworks strengthen sustainability in decision-making (e.g. DENR AO 2022-04 on biodiversity monitoring; PENCAS Act 2024, integrating natural-capital accounting into EIAs)	• Complex and lengthy permitting process • Limited length leases affecting economic and operating life of projects • Transition of national and local leaderships and associated policy changes • Lack of policies to support the development of domestic processing • Strong regulations but inconsistent implementation • Implementation challenges noted by stakeholders in FPIC processes and environmental enforcement
Integrated management of resources	• MFTR • Efforts to harmonise local and national laws and policies • PENCAS helps integrate biodiversity and water values into land-use and mining decisions	• Conflicting laws and policies at the national and province level • Overlapping responsibilities of organisations • Unclear or overlapping land use/ tenements • Land-use disputes • Effects of multi-hazards and climate change • Outstanding ancestral-domain registration and land-tenure overlaps

UNRMS principle	Strengths	Challenges
Value addition	• Potential for renewable energies to reduce costs • Increasing global nickel demand • Nickel mining contribution to economy • Establishment of novel technologies and approaches for nickel and co- and by-products • Policy tools to catalyse downstream investments (e.g. Strategic Investment Priority Plan; Board of Investments (BOI) 'green lane'; eco-industrial zones) • Domestic HPAL capacity	• High energy costs: fossil-heavy grid raises costs and carbon intensity • Reliance on DSO and limited domestic processing • Volatility of nickel prices affecting production costs and attraction of investors and projects • Bottlenecks: (local) transportation and shipping • Technical challenges (processing capacity) • Complex policy environment deterring investment
Comprehensive resource recovery	• Potential for carbon dioxide capture and construction products from waste	• Economic losses from unaccounted components in DSO • Technical and economic hurdles slowing adoption of 'full-value' mining
Circularity	• Increasing focus on waste and tailings as potential resources • Active research and development on circularity initiatives (e.g. tailings; reprocessing; hyperaccumulators)	• Circular initiatives remain at pilot or early scale and require development
Innovation	• Increasing use of digital tools and technology • Strong research work on mineral processing for co- and by-products (chromium; cobalt; scandium) • Department of Information and Communications Technology (DICT) • Demonstrated recovery of scandium; operating HPAL plant(s) provide platform for tests and innovation • Active international research collaborations	• Complexity of scaling from laboratory to commercial scale • Costs of new technology slowing implementation • Lack of full geochemical and mineralogical understanding of deposits at trace element levels, relevant to the recovery of co- and by-products

UNRMS principle	Strengths	Challenges
Responsibility to the planet	• Biodiversity protection efforts • Department of Energy (DOE)'s Philippine Energy Plan • Successful rehabilitation efforts and examples • Implementation of monitoring and safeguards • FMRDP, EPEP and MMT • Routine quarterly monitoring and penalties	• Mining-related biodiversity disruption and loss • Legacy mine closure and tailings-management challenges • Pollution from mining activity • Monitoring challenges and complexities of MMT • Lack of baseline data for environmental factors • GHG intensity: fossil-heavy power mix and energy-intensive processing
Social engagement	• SDMP • FPIC and National Commission on Indigenous Peoples • Economic development opportunities • Community support for mining • Information, education and communication: engaging the public in dialogue on mining	• Complexities of engaging in meaningful dialogue and meaningful participation • Poor public perception of mining industry • FPIC process complexity • Difficulties in benefit-sharing and SDMP delivery • Land-use conflicts and overlaps • Post-closure impacts and plans for communities • Risks faced by environmental and human-rights defenders; need for strengthened protection measures
Transparency	• Implementation of London Metal Exchange standards • Existing transparency initiatives, e.g. Philippines EITI • Mandatory sustainability reporting for listed companies	• Lack of transparency and disclosure of reports, information and data such as ECCs • Perceived corruption risks and integrity challenges • Company participation in transparency initiatives, while broad, is not ubiquitous
Health & safety	• Comprehensive legal and health and safety frameworks • Regular emergency-response drills • Mandated incident reporting	• Health and safety risks in the industry • Naturally occurring asbestos (NOA) minerals and hexavalent chromium in laterites
Continuous strengthening of core competencies and capabilities	• Efforts to lower energy costs • Phased transition to greener, renewable energy sources • Adequate supply of trained and skilled workforce • Availability of in-country testing capabilities • Capacity-building initiatives • University programmes in mining and metallurgy	• Lack of technical expertise in regard to processing, with little knowledge transfer or upskilling opportunities • Inconsistencies in central databases and data transparency initiatives • Skilled workers seeking overseas employment, impacting quantity and skills of domestic workforce

Philippine nickel industry vision statement

This vision statement was developed by BGS on the basis of stakeholder input gathered through workshops, meetings, follow-up discussions and a feedback round on a preliminary draft. It was also used to guide and inform the development of this roadmap.

Vision statement:

> “To develop a world-leading nickel industry that responsibly supplies global markets, embeds ESG best practices and disaster-risk reduction management across the value chain, and creates greater domestic value through expanded downstream processing and circular economy approaches. Through a proactive policy and innovation environment, strategic partnerships, and meaningful stakeholder dialogue, the industry will contribute to resilient and diversified global supply chains while ensuring that development is undertaken with due consideration to the whole of society and delivers equitable economic, social and environmental benefits.”

Progressive rehabilitation of mined areas at Rio Tuba Nickel Mining Corporation, Palawan. Reproduced with permission from Nickel Asia Corporation.

The roadmap

To inform the roadmap, we conducted a series of in-country, stakeholder-led workshops in collaboration with key sector actors. The focus included:

- discussing the current nickel industry landscape in the Philippines
- gauging the strengths and drawbacks of current legislation
- understanding the mining life cycle in its entirety

The workshops are described in Appendix 1. The results were used to create the roadmap framework in respect to the UNRMS principles, highlighting areas of existing strength and future development to benefit the nickel industry.

State rights and responsibilities in the management of resources

In the Philippines, strong mining legislation and recent policy reforms provide a solid basis for responsible resource management. The 1995 Philippine Mining Act is widely regarded as a robust foundation for the industry. Building on reforms already underway, stakeholders highlighted opportunities to streamline permitting further, including digitising approvals and harmonising policies, supporting timely and consistent implementation across agencies and developing in-country processing aligned with environmental and social objectives. Streamlining efforts should be undertaken without diminishing statutory requirements, assessment of technical and financial capability to undertake activities and due process in the approval or denial of mining permits and contracts.

Action areas:

1. Establish long-term, coherent policy frameworks:
   - 1a. Create long-term policies that can outlive political cycles, including national-level planning, environmental regulations and transparent data systems; for example, publishing a cross party, 10 to 15 year national nickel policy statement covering ESG requirements, value addition, energy and incentives
   - 1b. Advance land use planning and minerals sector reforms through existing statutes and, where appropriate, consideration of pending proposals (for example, National Land Use Act; proposals such as the Alternative Minerals Management Bill and Transition Minerals Bill) to improve clarity on safeguards, land allocation and investment certainty
   - 1c. Continue to develop and refine a comprehensive critical minerals strategy, aligned across agencies and regions, both at national and local government levels. Supported by a policy and investment framework that promotes ESG excellence, innovation, responsible value addition, and strategic international partnerships
   - 1d. Encourage and pursue enactment of existing policy and legal frameworks (for example, PENCAS) while ensuring new contributions align with predecessors where relevant
2. Continue streamlining and strengthening of regulatory processes:
   - 2a. Continue to improve the permitting process by streamlining permits across agencies through the Anti-Red Tape Authority and eliminating redundant steps, developing digitisation, shorter timelines and clarity of requirements while maintaining a robust system
   - 2b. Amend regulations to allow mineral processing permits greater than 25 years, enabling longer-term investments in downstream industries
   - 2c. Continue implementation of MFTR, ensuring transparent reporting, capacity-building for local government units (LGUs)
   - 2d. Resolve 'vested rights' and 'prior rights' issues to reduce disputes and uncertainty in resource governance. This can be

pursued through clear rules on rights prioritisation, comprehensive mapping of existing claims, and fair, transparent processes for resolving overlaps between legally vested and prior customary or ancestral rights

3. Strengthen regulatory environment to uphold ESG standards and public trust:
   - 3a. Enhance enforcement of environmental and social regulations, with stricter penalties for non-compliance and incentives for good performance
   - 3b. Reinforce integrity measures, for example:
     - i) declarations of interest for regulators and MMT members
     - ii) periodic rotation where appropriate
     - iii) confidential reporting channels with defined handling protocols
   - 3c. Establish options to strengthen enforcement and implementation capacity; for example, dedicated units or enhanced mandates within existing agencies to investigate, monitor and issue compliance directives
   - 3d. Strengthen and maintain measures that protect environmental and human rights defenders, including safe reporting channels such as feedback reporting by the Philippines EITI and swift protection mechanisms consistent with national and international commitments
   - 3e. Establish mechanisms to resolve overlapping or competing rights transparently, including by cross-referencing tenement coordinates with beneficial ownership data held by the Philippines EITI in order to identify potential conflicts of interest or monopolies
4. Develop domestic processing and value addition:
   - 4a. Define clear, staged policy objectives for domestic processing and nickel value addition, aligned with value addition, energy planning, infrastructure development and ESG factors.
   - 4b. If measures affecting DSO are considered, consider a phased integration with readiness assessments (covering processing capacity, workforce, etc) and impact analysis, with appropriate transition support
   - 4c. Develop integrated energy and infrastructure ecosystems that support competitive, resilient and sustainable downstream industries, including reliable low-carbon power, transmission, ports, logistics, water infrastructure and industrial zones, mobilising international investment and technical partnerships
5. Enhance state capacity and partnerships:
   - 5a. Consider options for greater state involvement and support, such as expanding the mandate of the Philippine Mining Development Corporation or establishing a new government mining agency to enable joint ventures (public-private partnerships), enabling greater potential for state oversight of ESG initiatives and mining practices
   - 5b. Expand financing opportunities through government programmes, including infrastructure support, technical studies and ESG-aligned funds for projects demonstrating high sustainability performance
6. Harmonise and coordinate partnerships:
   - 6a. Align regional and international partnerships with national priorities set out in a critical minerals strategy, with transparent coordination among donors, national government and LGUs to avoid overlaps and sequence initiatives effectively
   - 6b. Create a harmonised multi donor programme initiative, coordinating donor projects, technical studies and capacity-building programmes

Integrated management of resources

Integrated management of resources ensures that mineral development is planned, regulated and monitored through a coordinated, whole-systems approach. In the Philippines, where mineral resources, biodiversity, ancestral domains, protected areas and hazard-prone regions often overlap, integrated management is essential to minimise conflict, strengthen land-use planning and improve environmental and social outcomes. By harmonising data, clarifying institutional roles, digitising permitting and embedding multi-hazard resilience across the mine life cycle, the sector can operate more efficiently, transparently and sustainably while reducing risks to communities and ecosystems. Integration efforts should recognise respective agencies' roles and be undertaken in a collaborative manner.

Action areas:

1. Improve institutional coordination through a whole-of-government approach:
    - 1a. Harmonise national and local government implementation through improved data sharing, aligned requirements, standardised compliance systems, and coordinated permitting processes, while maintaining regulatory robustness.
    - 1b. Clarify institutional roles, responsibilities and accountabilities across the mining project life cycle by:
        - i) establishing clear service-level agreements for agency responses
        - ii) defining a structured dispute-resolution pathway to improve efficiency and predictability
        - iii) publishing a responsible, accountable, consulted and informed (RACI) matrix for the Mines and Geosciences Bureau (MGB), the Environmental Management Bureau (EMB), the National Commission on Indigenous Peoples (NCIP), LGUs and other relevant agencies

      A RACI matrix is a management tool that clarifies the roles and responsibilities within a project and categorises tasks assigned to individuals or groups.

      The disaster risk reduction and management coordination model, where relevant departmental remits are centrally coordinated, could be an example model
    - 1c. Strengthen the whole-of-government approach by furthering formal coordination mechanisms among national agencies, LGUs, communities, and industry bodies, including joint planning processes, clearly defined agency roles, and consistent guidance for proponents. This would help reduce duplication, improve policy coherence, and support more effective delivery of local economic development outcomes
2. Strengthen national and integrated geospatial datasets:
    - 2a. Upgrade centrally held datasets to digitally accessible and interoperable formats, improving ease of data sharing and updating
    - 2b. Develop a centralised, interactive, national database to improve understanding of nickel laterite geology and deposits in the Philippines, which should compile information on:
        - i) geographical location
        - ii) areal extent
        - iii) ore grade parameters
        - iv) mineralogical and geochemical attributes (where available)
        - v) national data on mineral resources and reserves, including co- and by-products, to strengthen mineral asset accounting
    - 2c. Develop an integrated geospatial management platform that links mineral occurrence and deposit data with current mining operations, processing plants, tailings storage facilities (TSFs) and disclosed fiscal data, and integrates them with:
        - i) land use
        - ii) population centres
        - iii) catchments
        - iv) biodiversity
        - v) water resources
        - vi) other environmental and social datasets

      The platform should capture social and environmental aspects, including proximity to water supply reservoirs and protected areas

3. Integrate land-use planning, tenure systems and operations siting:
    - 3a. Harmonise and reconcile land-use maps, land classifications, mining tenements and relevant policies across government to reduce overlaps and support consistent, transparent decision making across agencies and jurisdictions
    - 3b. Integrate ancestral domain maps, protected area boundaries, land-use plans and geological data into a single, authoritative geoportal to be used as part of the permitting process to pre-emptively identify land-use overlaps. This should be done in collaboration with and have direct input from Indigenous Cultural Communities and supporting groups, for example NCIP, the Philippines EITI and the University of the Philippines Institute of Human Rights
4. Integrate multi-hazard and climate risks across the mining lifecycle:
    - 4a. Create a national multi-hazard risk assessment framework and model integrating geological and hydrometeorological hazards, identifying areas of highest risk, and coordinated with:
        - i) Philippine Institute of Volcanology and Seismology
        - ii) Philippine Atmospheric, Geophysical and Astronomical Services Administration
        - iii) Mines and Geosciences Bureau
    - 4b. Embed disaster risk reduction and climate change adaptation across the entire mining process, covering all four thematic disaster risk reduction components:
        - i) prevention and mitigation to avoid and limit risks
        - ii) preparedness to build capacity for response
        - iii) response to provide immediate relief
        - iv) rehabilitation and recovery to rebuild both livelihoods and infrastructure
    - 4c. Require site-level risk-management systems for mining assets (for example, automatic weather stations installed and maintained by mine operators)
    - 4d. Ensure that the framework applies across the full life cycle and accounts for compound and cascading hazards affecting mining regions
    - 4e. Ensure that all multi-hazard and climate risk integration efforts are harmonised with the contingency plans and disaster risk reduction and management plans of the local government where the mining company is situated

Value addition

In the Philippine nickel industry, value addition can be achieved by shifting away from reliance on DSO and prioritising the development and expansion of the downstream processing sector. This strategic shift would position the country to capture greater economic benefit from its mineral resources while supporting broader national industrialisation goals. A holistic approach to value addition would ensure that industry, government, research and society all participate in and benefit from the sector, prioritising environmental sustainability through responsible mining and processing practices. Value-addition initiatives align with the Strategic Investment Priority Plan, especially the listed priority activities that are connected to the nickel sector, 'green ecosystems' (including manufacture of electric vehicle components, renewable energy and energy storage technologies) and 'industrial value-chain gaps'.

Action areas:

1. Develop an industrial strategy for the responsible growth of the domestic nickel industry:
    - 1a. Conduct studies to map and regularly update nickel, co-product and processing supply chains, enabling early identification of risks and investment opportunities
    - 1b. Set long-term goals and develop an associated policy framework for transitioning from DSO to higher-value processed products, including benchmarking against peers and defining appropriate milestones
    - 1c. Enable transparent monitoring of fiscal incentives for the transition to higher-value processed products where they are considered or implemented, to ensure value-

addition activities are effective in generating a net increase in value within the Philippines

2. Expand and strengthen the downstream sector:
   - 2a. Increase domestic processing capacity by upscaling existing plants and building new facilities to build processing capacity. In the short term, the country may need to strengthen current partnerships (for example, Sumitomo) and pursue technology partners while domestic technologies and capabilities are developed and commercialised. This should be complemented by continuous research and development, feasibility studies and technology assessments comparing processing routes for Philippine nickel laterite ore types (HPAL variants; atmospheric-pressure leach[2]; deep eutectic solvents[3]; ferronickel), considering power cost, logistics and the environment
   - 2b. Address transport and shipping bottlenecks (for example, road networks; port capacity; inter-island shipping) to lower logistics costs, improve the movement of unprocessed ores across the country and enable blending and feed optimisation for processing plants could be supported by a national logistics plan for the nickel sector to support multi-modal transport efficiency
   - 2c. Continue to improve the energy landscape in line with the DOE Philippines Energy Plan; for example, continue to develop the integration of renewable energy (for example, geothermal; solar) and nuclear sources and address bottlenecks in the energy grid and transmission system, which may shift the economic viability of energy-intensive processing routes such as smelting
   - 2d. Improve export valuation of unprocessed and processed ores by including co-products (for example, chromium; cobalt; scandium) and potential for precious metals (for example, palladium; platinum) as analytical and processing capabilities are upgraded
   - 2e. Progressively develop the markets and supply chains through diversifying export markets and creating local markets for nickel products
   - 2f. Capitalise on funding from development finance institutions, green finance facilities and climate-aligned funds to support processing infrastructure
   - 2g. Improve policy and regulatory support through implementing incentive frameworks (for example, 'Green ecosystems' and 'Industrial value-chain gaps' of the Strategic Investment Priorities Plan, the Board of Investments Green Lane programme and the Philippine Economic Zone Authority economic and industrial zones) that could catalyse domestic processing while ensuring international trade compliance
   - 2h. If measures affecting DSO are considered, also consider phasing and pairing them with robust support for processing (for example, power; research and development; investment facilitation), following readiness assessments and impact analysis
   - 2i. Continue to explore and map eligibility for EU Critical Raw Materials Act (CRMA) strategic-project criteria, US Department of Energy critical materials programmes and other funding initiatives to expand and diversify potential financial support and offtake routes

[2] Hydrometallurgical process that operates at near-ambient pressure.

[3] Specialised solvents used to dissolve and recover metals.

Comprehensive resource recovery

Comprehensive resource recovery is central to maximising the value of the Philippines' nickel deposits while reducing environmental disturbance and waste generation and rectifying missed economic opportunities.

Because laterite deposits are inherently heterogeneous and contain a wide suite of metals and mineral components beyond nickel, effective recovery depends on a detailed understanding of ore characteristics and modern analytical capacity. Strengthening geoscientific datasets, laboratory infrastructure and coordinated mineralogical studies enables more efficient processing, minimisation of hazardous residues and identification of additional marketable products. At the same time, the integration of emerging technologies, such as carbon dioxide (CO_2) mineralisation[4] and multi-metal extraction, supports both resource efficiency and climate objectives. By adopting a whole-deposit approach, the Philippines can improve economic returns, enhance environmental stewardship and establish a globally competitive and future-ready nickel laterite industry.

Action areas:

1. Enable full recovery of resource value through comprehensive material understanding:
   - 1a. Building on the work of MGB, assess the presence, distribution and resource potential of critical and technology metals and identify their mineralogical hosts to determine their recoverability, processing implications and viability as value-adding commodities
   - 1b. Conduct detailed material characterisation to identify additional mineral components that may support technological uses, including geopolymers for construction and ceramic wares (Promentilla et al., 2021), silica for construction and glassmaking, and iron and magnesium for CO_2 mineralisation
   - 1c. Ensure analytical efforts integrate multiple scales and techniques and are centrally coordinated, enabling consistent and high-quality data generation to support resource-recovery decisions
2. Re-assess and improve processing to maximise output and minimise waste:
   - 2a. Enable the extraction of economically significant minor and trace metals in addition to nickel by enhancing recovery pathways for chromium, cobalt and scandium and, where present in meaningful quantities, the platinum group metals and rare earth elements. These typically occur at low concentrations and require comprehensive mineralogical characterisation, the Taganito HPAL plant's production of chromium and scandium alongside mixed nickel/cobalt sulfide demonstrates the feasibility of by-product recovery
   - 2b. Facilitate integration with CO_2 mineralisation technologies by introducing a CO_2 stream (for example, from flue gas or direct air capture) into the ore-processing flowsheet after metal recovery, subject to Philippine regulatory approvals and environmental safeguards. This will allow CO_2 to become crystallographically bound within iron and magnesium carbonates, offering the potential to offset HPAL emissions while stabilising or reducing waste toxicity. Carbonated mine waste may be used industrially (for example, in cement and plasterboard) (MCi Carbon, 2025). Achieving effective CO_2 mineralisation or HPAL integration will require substantial research and cross-disciplinary collaboration between industry and scientific partners

[4] Process that converts CO_2 gas into mineral(s) by reacting with Mg- and Fe- bearing materials.

Circularity

Nickel laterite mining in the Philippines generates vast volumes of metal-bearing waste. This can be a valuable additional resource when accounted for in the mining process. Techniques such as electrokinetic in situ leaching[5] offer the potential to reduce mining footprints while extracting additional value (Martens et al., 2021). Tailings are also being repurposed for construction materials, CO_2 sequestration and other industrial uses. Given the large volumes of tailings in the Philippines, integrating these approaches will support circularity by keeping materials in use longer, reducing waste and improving both economic returns and environmental performance.

Action areas:

1. Progress utilisation of mine waste and tailings:
   - 1a. Develop national-scale exploration and assessment of potential mine waste and residue resources to identify those prospective for reprocessing and develop understanding of potential resources
   - 1b. Develop national standards for laterite waste products
     - i) approve specifications for bricks, ceramics and road base using laterite residues
     - ii) align approval process and quality assessment and control, to streamline uptake
   - 1c. Investigate nickel hyperaccumulator systems on mined out land to couple rehabilitation with phytomining[6]
   - 1d. Conduct material flow analyses to map nickel mass flows (ore → product → residues and tailings) to identify viable by-product and secondary resource opportunities
   - 1e. Research and assess mine waste repurposing pathways such as:
     - i) converting siltation pond material into ceramic tiles (Bernardo-Arugay et al., 2022)
     - ii) using laterite residues in asphalt concrete (Medina García et al., 2023)
     - iii) producing high purity magnetite from iron-rich tailings for water remediation uses (Opiso et al., 2023)

Innovation

Innovation is instrumental not only for enhancing economic competitiveness in the Philippine nickel sector, but also for enabling responsible mining, reducing environmental impacts and unlocking new value streams. These action areas outline how increased use of digital tools, novel processing approaches, improved monitoring systems, waste transformation and better research on industry pipelines can collectively strengthen the sector's sustainability and value-addition potential. A robust and integrated database system will be necessary to facilitate and establish transparent and investor-accessible data platforms.

Action areas:

1. Strengthen digitalisation and advanced data tools that can improve exploration efficiency:
   - 1a. Develop data-driven predictive modelling using machine learning, which can enhance prospectivity mapping and accelerate exploration. Machine learning has already been successfully applied to copper and gold deposits in the Philippines (Carranza and Laborte, 2015), demonstrating strong potential for nickel
   - 1b. Adopt cloud-based geological databases and geospatial platforms to support evidence-based decision making across the sector

[5] Technique that applies electric fields underground to aid leachate flow to extract metals.

[6] Using metal-absorbing plants to remove metals from soil or mine waste, then harvesting/recovering.

1c. Carry on updating the geochemical and mineral resource inventory databases continuously, to enhance mineral prospectivity analysis and exploration targeting

2. **Accelerate research and innovation in exploration, mining and resource recovery for value addition while minimising environmental impact:**

   2a. Develop research and implementation of phytomining and in situ mining methods that could reduce surface disturbance

   2b. Develop sustainable processing technologies that use environmentally benign solvents (for example, organic acids vs. conventional strong acids), less energy-intensive comminution strategies and CO_2 integrated into ore-processing flowsheets that reduce carbon emissions and increase mineral carbonation potential

   2c. Continue to develop tailings-based metal recovery, such as in situ leaching, within TSFs. Joint projects between the Philippines and the UK, such as the Philippine Remediation of Mine Tailings, have demonstrated that environmentally benign solvents can extract metals from mine waste and tailings

3. **Advance environmental monitoring technologies to strengthen environmental management, community trust and rapid response:**

   3a. Continue to develop real-time monitoring systems for water, soils and air quality that are equipped with automatic alarms and emission control triggers.

   There are already advanced machine learning models for soils based on spectral data that could be explored for monitoring contamination (for example, Li et al., 2025)

   3b. Roll out rapid response monitoring for community water sources near nickel laterite operations to provide assessment and early warning of issues

   3c. Increase implementation of Earth observation tools, including InSAR, drone-based photogrammetry and hazard analytics, for environmental assessments and continuous monitoring of TSFs, slope stability and landslides in nickel laterite areas (including legacy facilities)

4. **Promote innovation in waste utilisation, treatment and rehabilitation:**

   4a. Incentivise mining and processing companies to pursue waste utilisation and circularity initiatives, including technologies that convert tailings, residues and by-products into useful materials

   4b. Increase research on ecological restoration, including trials with native species, soil-amendment technologies and nature-based solutions, to rehabilitate mined-out areas and reduce long-term environmental liabilities.

   The Department of Science and Technology (DOST) National Research Council of the Philippines' 'Greening mined-out areas in the Philippines' (GMAP) programme is an initiative that focuses on restoration of mining areas through microbial-based and bioremediation technologies[7] (National Research Council of the Philippines, 2025)

5. **Build a research-to-commercialisation pipeline:**

   5a. Implement and expand government–industry–research coordination mechanisms, such as multi-sectoral technical working groups, to prioritise innovation needs and disseminate research outputs. Further utilise programmes such as 'Propelling Innovations from the Philippines', which aims to bridge the gap between research and industry application

   5b. Make research funding mechanisms long term, with dedicated support for scaling-up promising technologies, which could be built upon:

   i) DOST programmes such as 'Niche centres in the regions for research and development' or 'Collaborative research and development to leverage Philippine economy'

   ii) national science and technology funding

   iii) innovation financing programmes (for example, the Philippine Innovation Act)

[7] Using microorganisms to break down or neutralise contaminants in soil, water, or mine waste.

iv) industry support

v) international collaboration

5c. Introduce and ringfence a specific research-industry partnership fund providing competitive grants for downstream processing capacity and technical innovation

5d. Support technology demonstration and pilot facilities to test promising technologies under operational conditions. Such support on a larger scale has been demonstrated by European Union projects such as RAWMINA (2021 to 2025), which developed a sustainable pilot system to recover critical raw materials such as antimony, cobalt, germanium and tungsten from mine waste

Responsibility to the planet

Protecting the environment is central to the Philippines' ambition to supply responsible, low-impact nickel for the global energy transition. As one of the world's most biodiverse and climate-exposed countries, the Philippines must ensure that nickel extraction and processing minimise ecosystem disturbance, avoid irreversible environmental damage and promote long-term restoration of ecological function. Achieving this requires strong alignment with international environmental standards, holistic assessment of cumulative impacts, improved environmental datasets, strengthened rehabilitation frameworks and active approaches to climate mitigation and biodiversity conservation. By embedding these practices throughout the value chain, the sector can reduce harm while maximising social, ecological and economic benefits

Action areas:

1. Align with international ESG and environmental performance standards:

   1a. Review international ESG standards and assess their suitability for adoption within the Philippine nickel industry as part of aligning with global best practice and building on existing transparency mechanisms (such as EITI) and standards (such as TSM)

   Potential items for review include:

   i) Consolidated Mining Standard Initiative

   ii) Initiative for Responsible Mining Assurance

   iii) The Nickel Mark

   iv) Global Industry Standard on Tailings Management

   The review should consider feasibility, capacity needs and pathways for progressive adoption

2. Improve the availability and quality of national environmental baseline datasets:

   2a. Strengthen national datasets for biodiversity, hydrology and natural (old growth) forests. Establish a consensus definition of 'natural/old growth forest'. Prioritise systematic biodiversity inventories in mining affected regions. Increase transparency and access to baseline data

3. Evaluate mining impacts comprehensively, and at catchment scale:

   3a. Conduct comprehensive evaluations of proposed facility sitings to minimise adverse effects on biodiversity and surrounding communities, including impacts which extend beyond the facility footprint. Safeguard local populations from contamination of water, air and soil throughout the entire life of the mining project. Initiate baseline geochemical and mineralogical studies before mining begins and maintain them throughout the project to enable robust monitoring and transparent reporting

   3b. Trial Strategic Environmental and Social Assessments (SESAs) to address cumulative impacts where multiple operations share the same catchment or region — SESAs can:

   i) evaluate regional hydrological, ecological and social effects

   ii) improve planning decisions

   iii) anticipate cumulative risks

   iv) strengthen cross-agency coordination beyond project level assessments

4. Reduce greenhouse gas emissions, expand renewable energy uptake and integrate life cycle assessment:

   4a. Support decarbonisation of nickel operations by continuing to deploy

renewable energy, capitalising on international partnerships (for example, UK PACT) and integrating emissions reduction plans into feasibility studies and operational reviews, especially for HPAL and diesel fleets. This should be done in alignment with international net zero frameworks such as the CCSI Net Zero Roadmap for Copper and Nickel (World Bank, 2023), which emphasises prioritising absolute emissions reductions and structured transition pathways

4b. Encourage or mandate disaggregated GHG emissions reporting to enable transparent identification of priority areas for emissions reduction, as per requirement 3.4 of the EITI Standard

4c. Promote life cycle assessment (LCA) at the pre-feasibility stage for new nickel projects, utilising LCA outputs to inform mine planning, processing technology selection and market transparency

4d. Conduct a national LCA of the nickel industry to guide strategies for decoupling industrial growth from environmental impacts

5. Strengthen water stewardship and management:

5a. Create site-specific erosion and sediment control plans with storm design criteria, covering haul road drainage and stockpiles and including rapid response tools (for example, silt curtains during heavy rain)

5b. Include Cr(III)/Cr(VI) speciation[8] in baselines and routine monitoring; where Cr(VI) occurs, implement reduction, filtration and adaptive management to comply with water quality limits

5c. Engage local communities, rights holders and stakeholders in water monitoring, reporting and decision making to ensure transparency, equitable access and alignment with social and environmental standards

5d. Expand deployment of continuous sensors for flow, turbidity, pH and electrical conductivity at compliance points. Publish concise monthly dashboards via the EMB and MMT and host time-series data on an open geoportal for basin-wide use

5e. Expand the national dataset on hydrology and water quality in the Philippines beyond selected regions of Luzon and Mindanao (Biles et al., 2026) to incorporate current and future nickel laterite mining operations and strengthen the baseline for metal concentration monitoring

5f. Philippine Hydro Hub collaboration: The Philippine Hydro Hub is an open-access platform, developed through a partnership between BGS, Ateneo de Manila University, and the University of the Philippines, that provides national hydrological datasets, models, and tools to support water resource management and climate resilience. This platform can be leveraged for hydrological datasets, models, and tools, and co-deliver workshops to enhance regulator, LGU, and operator capabilities.

6. Advance nature-positive mining, biodiversity protection and rehabilitation:

6a. Develop national mining and mine-restoration standards incorporating net-positive and nature positive principles; priorities, which can build on the GMAP programme, include:

i) scaling biodiversity-supportive initiatives for post-mining landscapes (for example, Bio+Mine project concepts) (BioPlusMine, 2025)

ii) expanding native species nurseries to match rehabilitation demand

iii) furthering use of native species targets, survival rate thresholds and outcome metrics (soil; hydrology; habitat)

iv) requiring independent third party audits

6b. Adopt a mitigation hierarchy for biodiversity in mining and apply the sequence: avoid → minimise → restore/rehabilitate → offset residual impacts. Where national guidance evolves, offsets should be considered only after robust avoidance and minimisation, with particular caution in critical habitats and with participation of Indigenous Peoples and local communities. The International Council on Mining and Metals has committed to a 'nature positive' approach, halting biodiversity loss at operations using a 2020 baseline, guided by the Kunming Montreal Global Biodiversity Framework

[8] Cr occurs in different forms (oxidation states) two of which are Cr(III), which is relatively harmless, and Cr(VI), which is toxic.

(ICMM, 2025). In one of the most biodiverse countries in the world, a similar approach could represent a significant opportunity for the Philippines and the world to regain crucial biodiversity and ecological function

6c. Upscale and introduce emerging remediation methods for heavy metals (including Cr(VI)), such as charcoal-based filters and other filtration technologies, reducing reliance on passive wetland systems whose performance can be highly site dependent

6d. Investigate best practices for the rehabilitation of mine sites where NOA in the bedrock may have been exposed; for example, capping of exposed bedrock

6e. Publicly share best practices and innovations in tailings and biodiversity management, demonstrating leadership and facilitating sector-wide education, continuous improvement and transparent reporting

6f. Broaden rehabilitation options to allow consideration of beneficial post mining land uses (such as renewable energy and constructed wetlands) by providing guidance and optional restoration pathway(s), in addition to 'original state' restoration

Social engagement

Social engagement is especially critical in the Philippines, where many deposits overlap with ancestral lands and rural communities whose livelihoods, cultural heritage and environmental security are directly affected by mining activities. Strengthening inclusive participation, transparency and communication helps to build trust in the mining sector. By embedding this principle into areas such as education and policy reform, the Philippines can support a more equitable expansion of its nickel industry.

Action areas:

1. Strengthen community engagement and benefit-sharing:
   - 1a. Strengthen the implementation and review of social development and community benefit-sharing frameworks, by ensuring they are community-led, inclusive and informed by meaningful participation at all levels of the community. This may include the use of an independent Indigenous Peoples or traditional community advisory panel to support transparent communication, oversee assessments and monitor direct remittance of royalties, and help ensure that benefits reflect community priorities
   - 1b. Research and create case studies where SDMPs and other community benefit-sharing initiatives have resulted in meaningful, lasting, positive change for the community, to showcase best practice and exemplify the types of possible projects to communities in discussions
   - 1c. Consider implementing defined dispute resolution mechanisms, including the implementation of multi-level mechanisms (local; regional; national) where a neutral party acts as mediator between the community and company in case of a dispute
   - 1d. Support informed community decision making by providing transparent, timely and culturally appropriate communication on project benefits and risks through trusted local communicators and mechanisms that allow questions, feedback and ongoing dialogue
   - 1e. Before mine closure, proactively co-design a community transition and legacy plan that is aligned with environmental rehabilitation and monitoring requirements so that social and environmental closure proceed together and involve communities, LGUs and operators, covering topics such as:
     - i) livelihood diversification
     - ii) re-skilling and job placement
     - iii) asset handover and maintenance
     - iv) ring-fenced post-closure social investment fund with community representation
     - v) long-term environmental/cultural heritage monitoring roles
2. Reinforce FPIC and Indigenous community engagement:
   - 2a. Work with key government agencies (for example, NCIP; DENR; LGUs) and Indigenous representatives to continue reinforcing Indigenous People's rights and

fit-for-purpose equitable benefit sharing aligned with the UN Declaration on the Rights of Indigenous Peoples. Policy refinements co-designed with affected communities, including safeguards and grievances (for example, clearer royalty administration and transparency), should be considered

2b. Consider ringfencing a dedicated FPIC budget within the NCIP, to ensure this process is adequately supported to run smoothly and effectively represent the needs of the community

2c. Create an independent FPIC support facility to provide legal and technical advice to Indigenous Peoples and traditional communities across the project life cycle (for example, consent pathways; contract and royalty review; environmental baselines), based on the community's articulated needs

2d. Establish co-designed pathways for Indigenous knowledge-sharing so operators and regulators can hear and understand Indigenous People's experiences with and knowledge of land, culture and resource stewardship using voluntary, consent-based mechanisms, for example:

i) participatory and cultural mapping

ii) Indigenous Peoples knowledge liaison roles

iii) dialogue forums

2e. Ensure that wide-ranging, meaningful dialogue and engagement with communities is carried out early on in the exploration and permitting process. Discussions should ensure that the customary habits of individual Indigenous Cultural Communities and how they may interact with potential mining operations are fully understood, appreciated and considered

3. Expand education and outreach:

3a. Continue to develop educational programmes on mining, tailored for host communities, to act as an information source

3b. Enhance earth science education by integrating Philippine content into the basic curriculum via improved information, education and communication (IEC). Start mining and environment modules early and include:

i) school visits by engineers, environment officers and geologists

ii) field trips

iii) rock kits showcasing critical minerals from the Philippines

3c. Implement the National Unified Information, Education and Communication Plan and cascade IEC materials through trusted organisations, using community radio, social media and travelling town halls. Highlight the role of minerals in national development and net zero pathways

4. Promote gender equality across the nickel sector:

4a. Create further and enhance existing education, outreach and networking programmes, including those arranged by Women in Mining ('Showcase best practice') and Philippines EITI (Women in Extractives Forum; regional roadshows)

4b. Improve workplace policies, such as parental leave and flexible working arrangements.

4c. Ensure suitable equipment, facilities and anti-harassment measures are in place

5. Strengthen social safeguards:

5a. Strengthen protections for community members and advocates by reaffirming existing legal commitments and improving the awareness and accessibility of confidential reporting channels (such as the Philippines EITI Feedback Reporting mechanism) with the shared aim of safe, respectful dialogue in mining-affected areas

5b. Consider establishing a defined reporting process that is not contingent on internet access, such as explicitly inviting confidential reporting and feedback at scheduled town halls

5c. Continue to promote regular, transparent dialogue between companies, regulators and communities (including Indigenous Peoples bodies) through scheduled town halls that publish monitoring results and agreed follow-ups

5d. Improve the implementation of legally defined sanctions where companies are found to have acted illegally, such as by mining beyond a permitted area or not meeting environmental procedures and standards

Transparency

Seen as a critical component of sustainable development, transparency underpins functional working partnerships and sector interoperability. Across the mineral sector, sharing information regarding finances, resource processing and management and environmental stewardships, if and where possible, could be improved to further build public trust and reduce corruption speculation.

After joining EITI in 2013 and publishing reports on progress, the Philippines EITI mandates that member companies disclose financial information such as revenue collection and allocation, in addition to contract and license details. To continue to develop these strengths, transparency must be accounted for across all sectors involved and components of a mine's life cycle.

Action areas:

1. Increase the availability and interoperability of standardised baseline data:
   - 1a. Develop open-access data policies, geospatial and monitoring data:
     - i) having data standards and, in turn, making data available for other organisations to use in their practices can alleviate many of the problems with siloed working
     - ii) geospatial data on mine footprints, ecological areas, land use and ancestral lands (and other, similar data) would benefit all parties and make outputs comparable
   - 1b. Move from aggregated company reporting to project-level disclosure of the specific impacts of individual mines within affected areas across the mine life cycle, to allow greater visibility for communities
   - 1c. Create best-practice (central, unbiased and seen as the guiding practice or standard) libraries to, for example:
     - i) showcase successful rehabilitation and restoration projects
     - ii) share challenges and successes regarding rehabilitation efforts
     - iii) share the research behind area-specific restoration and how it is monitored within the mine's life cycle
2. Develop policies and practices to support compliance with transparency initiatives:
   - 2a. Create reward systems for increased transparency, in the form of an unbiased panel review on a stakeholder-defined basis and linked to local involvement to ensure it is driven by those most affected
   - 2b. Increase disclosure and release of ECC or EIS material, in addition to initial scoping mineral studies, further exploration studies and plant operation monitoring.

     Availability and access can be encouraged through accountability and implemented through practiced laws
   - 2c. Strengthen interaction with the public and locals by actively communicating monitoring results and addressing concerns on a community-led timescale (via town halls)
   - 2d. Develop community-facing, data-driven information access, such as the Philippines EITI and GovData Initiative 'PREDIC' tool (GovData Initiative Inc., 2026) and the Philippines EITI Extractives Data Generator, so communities can better access and understand data on mining operations
3. Strengthen multi-partite monitoring teams for collaborative oversight:
   - 3a. Ensure selection criteria support diverse participation, including Indigenous Peoples, women, subsistence fishers and farmers, civil society organisations and academic partners
   - 3b. Encourage regular sharing of MMT data and key indicators in formats accessible to all rights holders and stakeholders, fostering open dialogue, cross-comparison and collaborative analysis rather than prescriptive publication mandates
   - 3c. Validate and investigate findings where possible, while diversifying participation across the various stages

Health and safety

Health and safety in the Philippine mining sector is a critical consideration throughout the entire value chain, with hazards ranging from physical injury and geohazards to chemical exposure and poor air quality. Robust, well-implemented safety systems are essential to minimise harm, particularly in a country highly prone to earthquakes, typhoons and cascading multi-hazard events.

Effective health and safety management extends beyond the workforce, safeguarding nearby communities through rigorous incident reporting, communication protocols and active monitoring of risks such as tailings dam instability and contamination. Strengthening health and safety practices not only protects workers and local populations, including consideration of Indigenous Peoples and Indigenous Cultural Communities, but also supports social acceptance, regulatory compliance and the long-term sustainability of the mining industry.

Nickel laterite mining mobilises potentially toxic metals and mineral particulates, including naturally occurring asbestiform minerals. These contaminants may be transported via dust or water, increasing exposure risks for both workers and surrounding communities.

Action areas:

1. Strengthen health and safety standards:
   - 1a. Baseline air-quality studies and seasonal monitoring during both dry and wet periods. Install monitoring stations around open-pit sites and downwind residential areas, integrating measurements of asbestiform minerals, silica and heavy metals into environmental and health-risk assessments
   - 1b. Create further guidance, monitoring and protective measures to safeguard workers and nearby communities from NOA. Existing rules (for example, DOLE, 2016) regulate manufactured asbestos but do not explicitly address NOA in mining. New Caledonia's recognition of NOA in laterites as an occupational and environmental hazard (Congrès de la Nouvelle-Calédonie, 2010) provides an example policy model
   - 1c. Deploy a dust analysis programme to identify the presence of fibrous minerals and, where relevant, provide further guidance and protective measures for managing exposure to naturally occurring asbestiform minerals in laterites
   - 1d. Expand dust-suppression measures to reduce airborne hazards; for example, consider eco-friendly chemical binders (Arreza et al., 2026) in addition to or instead of water spraying that, due to increased evaporation, is less effective during hot and dry seasons
   - 1e. Continue regular medical checks for workers and local communities, including respiratory examinations and monitoring of urinary metal concentrations (for chromium and nickel)

Continuous strengthening of core competencies and capabilities

Continuous strengthening of core competencies and capabilities is essential for responsibly upscaling nickel mining in the Philippines, as it ensures that institutions, regulators and the workforce can keep pace with the technical, environmental and social demands of modern mining. Building expertise across education, governance, data management and strengthening cross-disciplinary collaboration enables the industry to operate to higher standards while supporting innovation and long-term competitiveness.

Action areas:

1. Increase education and training initiatives to align with the overarching aim for mining development across the Philippines:
   - 1a. Strengthen the capacity of local state universities in host provinces and municipalities:

     By enhancing their technical, research, and institutional capabilities, these universities

can actively contribute to research and development initiatives related to the management and sustainable use of resources. This will enable them to provide direct, context-specific expertise and support to local rights holders, stakeholders and decision makers

1b. Use disaggregated employment data (including by gender and role, such as that published by the Philippines-EITI) to identify gaps in the nickel workforce and target training funds effectively.

2. Continuously train and upskill workforce:
   - 2a. Develop holistic workforce skills through cross-training: developing technical staff's practical social-engagement skills (FPIC, stakeholder mapping, grievance handling, inclusive communication) and developing community/permitting teams' core technical literacy (orebody, processing, monitoring, multi-hazard basics) via short courses and role rotations
   - 2b. Expand continual capacity-strengthening frameworks for governance and regulatory roles, ensuring best practice throughout the supply chain
   - 2c. Enhance capacity-strengthening initiatives within the local community to enable qualified members to access technical and management positions within the company, which can strengthen community participation in decision-making processes, ensure that local perspectives are meaningfully integrated into operational strategies, and promote inclusive and sustainable development

3. Strengthen institutional capability and technical capacity:
   - 3a. Investigate the creation of a nickel (or critical mineral) centre of excellence, linking universities with industry for test work, pilot plants, internships and student and workforce training; some existing examples of similar initiatives include:
     - i) Chile's National Institute for Lithium and Salars (INLiSa), which is a public institution that develops scientific and technological capabilities for lithium and operates pilot-scale facilities to support technology development (National Institute of Lithium and Salars, 2026)
     - ii) the UK's Faraday Institution, which is the national institute for electrochemical energy storage research, bringing together universities, industry and government to deliver coordinated research, skills development and pilot-scale innovation across the battery supply chain (Faraday Institution, 2026)
   - 3b. Strengthen analytical laboratory capacity and capability by creation of new and modernisation of existing analytical infrastructures. Specifically, coordinated development of whole-rock geochemical laboratories, electron microscopy and X-ray diffraction facilities would provide core datasets for ore grade characterisation and geometallurgical analysis. This would support the development of innovative processing technologies to recover a diverse suite of metals and assess whole-rock utilisation potential
   - 3c. Increase investment in capacity strengthening across DENR, MGB, LGUs, and enforcement agencies, including training on ESG, environmental science, mineral economics, community governance, as well as mining legislation and regulatory frameworks to support implementation of mining laws and policies
   - 3d. Increase, encourage and provide a platform for industry collaborations, knowledge exchange and long-term partnerships across all mining scales and investigate building this into existing cross-industry events such as the Annual Mine Safety and Environment Conference, Philippines-EITI roadshows, etc

Mine Waste: Ni laterite mine, Zambales Province, Philippines. BGS © UKRI 2026.

Roadmap to action

This roadmap is designed to:

- help guide national and local policy, regulation and decision making
- inform corporate strategies
- shape civil society, research and donor initiatives

It aims to complement existing programmes and outline indicative pathways across governance, environmental performance, social engagement, value addition, circularity, transparency and capability building. Co-created with Philippine stakeholders, it is intended to be adopted, adapted, refined, and implemented according to local priorities. Ultimate implementation decisions rest with Philippine authorities and stakeholders and are therefore, not prescribed in detail.

Implementation will require coordinated action across government, industry, academia, civil society, rights holders and development partners, with Philippine stakeholders taking the lead. Structured multi-stakeholder consultation will be central to effective implementation, bringing together government, regulators, industry, local governments, Indigenous Peoples groups, civil society and academia. These dialogues should ensure legitimacy, inclusivity and responsiveness to emerging issues and support alignment with broader national priorities, including industrial policy, energy planning, climate commitments, biodiversity targets and fiscal reforms.

A potential path forward is for the MGB to lead the preparation of an action plan to operationalise actions from the roadmap in a collaborative and holistic manner. Experience from other mineral-producing jurisdictions shows that action plans can help mobilise stakeholders, clarify responsibilities, and translate strategic objectives into coordinated delivery. Chile's National Critical Minerals Strategy provides an example of an inclusive, long-term roadmap. The Kyrgyz Republic's EITI work plan also illustrates how extractive-sector priorities can be translated into structured activities. The action plan should establish a clear implementation framework comprising:

- defined timelines
- identified responsible and partner agencies
- measurable targets
- monitoring and evaluation mechanism(s)

Such a framework can align with existing Philippine regulatory frameworks and wider critical minerals strategies, including the recently established national policy framework for developing the critical minerals industry.

To support operational clarity, the action plan could set out respective duties and accountabilities through an RACI approach. This could clarify roles and map how these entities coordinate. It is worth noting that, where institutional adjustments or new initiatives are contemplated, they will require evaluation within existing civil service rules and budgetary frameworks before adoption. It is also worth noting that many action areas from the roadmap can be taken up directly by research institutions, civil society organisations, non-governmental organisations (NGOs) and the private sector.

Progress could be assessed through structured monitoring and reporting, with transparency maintained via regular updates, including independent review findings and agreed follow-up actions. Relevant indicators could include:

- median permit decision times
- the proportion of permits processed through digitised systems
- the share of projects implementing LCA and adopting renewable energy
- domestic processing throughput and product mix
- volumes of co- and by-products recovered
- the number of FPIC agreements concluded
- typical grievance resolution times

Implementation should also include periodic reassessment of external factors, such as global nickel demand, price cycles, policy shifts in key markets and ESG expectations. Consistent with the scope of this project, detailed key performance indicators (KPIs), targets and timeframes are not prescribed here; these are best developed and owned by Philippine stakeholders. The listed indicators are illustrative and should be refined, with baselines and targets set through a collaborative, Philippine-led, multi-stakeholder process.

Anchored in UNRMS principles and shaped by Philippine nickel industry stakeholders, this roadmap can help realise the Philippines' vision of becoming a global leader in responsible nickel supply and production, embedding ESG best practices, disaster risk management and equitable societal and environmental benefits.

Nickel laterite ore transportation. Reproduced with permission of Nickel Asia Corporation.

Nickel laterite ore processing through mobile crusher. Reproduced with permission from Nickel Asia Corporation.

Appendix 1 Methods

This section provides a summary of the approach taken and formulation of the roadmap.

A BGS team went to the Philippines in late October 2025. This included a site visit hosted by CBNC in Rio Tuba, Palawan. The site visit included presentations from environmental management and community relations teams and a tour of key facilities, including active and rehabilitated TSFs, operational monitoring sites, the dock, the storage area and the processing site. It also included a meeting with Rio Tuba Nickel Mining Corporation.

Four workshops were conducted, one in Puerto Princesa and three in Manila, covering four stakeholder groups:

a) academics and NGOs

b) regulators and governance bodies

c) Palawan-specific stakeholders

d) industry leaders

Workshops were held under Chatham House rules to encourage open and honest dialogue. The aim of the sessions was twofold: the PESTLE analysis was used to examine the current situation of the Philippine nickel industry, identifying challenges and strengths, while the action areas session sought to generate practical steps for the roadmap.

During the workshops, participants identified a total of 104 individual action areas before sorting and processing. As part of the sessions, participants were asked to prioritise and suggest timelines for these actions: around 85 per cent were considered high priority, around 14 per cent medium priority and around 1 per cent low priority. In terms of suggested timelines, around 67 per cent were categorised as short term, around 25 per cent as medium term and around 8 per cent as long term.

While these rankings and timelines provided useful context, it was decided not to include formal prioritisation or timelines in the roadmap at this stage. This decision reflects several factors:

a) the distribution of priorities and timelines was heavily skewed

b) different stakeholder groups had differing perspectives on urgency and feasibility

c) the workshops were intended primarily to gather ideas and shape the roadmap, rather than define detailed implementation schedules

Each PESTLE and action area from the workshops was documented on paper by participants and digitised by BGS facilitators. These results were then mapped against relevant UNRMS principles, forming the basis of the roadmap. An internal BGS workshop in early December 2025 collated these results, aligning the action areas with UNRMS principles.

Appendix 2 UNRMS principles

Table 2 Summary table of the UNRMS principles (UNECE, 2022).

UNRMS principle	Description
State rights and responsibilities in the management of resources	States hold sovereign rights over natural resources within their territories and therefore carry the primary responsibility for ensuring they are managed sustainably. This includes establishing long-term policies, laws, regulatory systems and competent institutions capable of overseeing resource development, production, use, re-use and conservation. Governments are expected to apply principles of good governance, coordinate across agencies, take a long-term view of societal costs and benefits and ensure resource management aligns with national strategies, sustainable development objectives and international commitments.
Responsibility to the planet	Sustainable resource management must prioritise the continued well-being of the Earth, human societies and ecosystems. This principle emphasises environmental limits, the need to balance benefits and impacts and the responsibility to avoid compromising the ability of future generations to meet their needs. It recognises that resource production often creates environmental pressures and therefore requires careful assessment of cumulative impacts, adherence to climate objectives and responsible use of land, water, energy and biodiversity. The overarching goal is to find a sustainable balance that maintains the integrity of natural systems.
Integrated and indivisible management of resources	Resource management must be conducted in an integrated, indivisible manner that aligns environmental, social and economic objectives under a full life cycle and systems-thinking approach. This principle rejects siloed decision making and instead promotes coordination across sectors, institutions and stakeholder groups. Integrated management considers cross-sectoral linkages, cumulative effects and trade-offs, ensuring that actions in one domain do not undermine outcomes in another. The approach requires LCA, shared information platforms and partnerships across public, private and civil society actors.
Social contract on natural resources	Sustainable resource management must be grounded in meaningful, ongoing engagement with all stakeholders affected by resource activities. This includes governments, industry, workers, customers, investors, communities and Indigenous Peoples. The principle stresses respect for human rights, cultural values, labour standards and FPIC. It recognises that resource projects can create significant social impacts, both positive and negative, and therefore require inclusive dialogue, transparent reporting, rights-based safeguards and mechanisms for addressing issues such as land rights, cultural heritage, gender equality and community health and safety.
Comprehensive resource recovery	Resource systems should maximise the recovery of all valuable components at every stage of operations, disturbing the environment as little as possible. This includes primary commodities, by-products, co-products, tailings, residues and other anthropogenic materials. Comprehensive resource recovery extends across the entire life cycle, ensuring that both tangible and intangible values are captured. The principle supports minimising waste, improving resource efficiency and advancing the decoupling of economic development from resource extraction volume.

UNRMS principle	Description
Value addition	Value addition involves enhancing the economic, social and environmental benefits of resources by supporting further processing, refining, manufacturing and associated services. It strengthens linkages across the value chain while contributing to local employment, industrial development and skills growth. This principle stresses assessing value-addition opportunities across the full life cycle, ensuring environmental and social viability and promoting partnerships between governments, the private sector, civil society and local communities. It encourages increasing local content and building resilient supply chains.
Circularity	Circularity promotes designing and managing resources so that materials remain in use for as long as possible, with waste prevention as the highest priority. It emphasises reducing and re-thinking resource consumption, improving product longevity and reparability and creating systems that enable re-use, recycling and regeneration of natural capital. Circularity reduces environmental impacts and supports responsible production and consumption as well as the transformation of residues into secondary resources. It is a core approach for achieving decoupling and transitioning toward a sustainable, low-waste economy.
Health and safety	This principle requires continual improvement of health and safety systems with the long-term goal of achieving zero harm. It applies across all stages of the resource life cycle, ensuring the protection of workers, nearby communities and the environment. Strong safety cultures, robust standards, emergency preparedness and responsible management of risks, including those associated with tailings, are central to sustainable resource management. Health and safety must be treated as a fundamental prerequisite rather than an operational add-on.
Innovation	Innovation supports the adoption of new technologies, approaches and hybrid systems that enhance sustainable resource management. It includes diversifying technologies, improving productivity and accelerating the transformation of scientific results into practical applications. This principle encourages continuous experimentation, learning and the development of new tools, such as digitalisation, hybrid technologies and novel production systems, that advance decoupling, efficiency and resilience. Innovation is essential for achieving higher levels of sustainable economic productivity.
Transparency	Transparent disclosure of information on resource revenues, expenditures, impact and value chains is essential for good governance, public trust and informed societal decision making. It helps reduce corruption, identify who benefits from resource activities and support fair and responsible management of resource wealth. It requires accurate, accessible and verifiable data across upstream, side-stream and downstream processes, enabling clear public understanding of how natural resources are used and how benefits are shared.
Continuous strengthening of core competencies and capabilities	Sustainable resource management requires ongoing development of institutional and human capacities. This includes strengthening cross-disciplinary expertise, technical skills, research capabilities and operational competencies across organisations involved in resource governance and management. Continuous learning, re-skilling and capacity building ensure that stakeholders can adapt to emerging technologies, evolving sustainability challenges and integrated approaches to resource management.

Acronyms and abbreviations

BGS	British Geological Survey
CBNC	Coral Bay Nickel Corporation
DENR	Department of Environment and Natural Resources (Philippines)
DMT	Dry metric tonne
DOE	Department of Energy (Philippines)
DOST	Department of Science and Technology (Philippines)
DSO	Direct shipping ore
ECC	Environmental compliance certificate
EIA	Environmental impact assessment
EITI	Extractive Industries Transparency Initiative
EMB	Environmental Management Bureau (Philippines)
EPEP	Environmental protection and enhancement programme
ESG	Environmental, social and governance
FMRDP	Final mine rehabilitation or decommissioning plan
FPIC	Free, prior and informed consent
GHG	Greenhouse gas
GMAP	Greening mined-out areas in the Philippines
HPAL	High-pressure acid leaching
IEC	Information, education and communication
InSAR	Interferometric synthetic aperture radar
LCA	Life cycle assessment/analysis
LGU	Local government unit
MFTR	Mining fiscal tax regime (Philippines)
MGB	Mines and Geosciences Bureau (Philippines)
MMT	Multi-partite Monitoring Team (Philippines)
Mt	Megatonnes (1 million tonnes)
NCIP	National Commission on Indigenous Peoples
NGO	Non-governmental organisation
NOA	Naturally occurring asbestos
PENCAS	Philippines Ecosystem and Natural Capital Accounting System
PESTLE	Political, economic, social, technological, legal and environmental
₱	Philippine peso
RACI	Responsible, accountable, consulted and informed
SDMP	Social Development and Management Programme (Philippines)
SESA	Strategic Environmental and Social Assessments
TSF	Tailings storage facility
TSM	Towards Sustainable Mining
UNRMS	United Nations Resource Management System

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