

# Mineral security essential to achieving the Sustainable Development Goals

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Minerals are essential ingredients of the Sustainable Development Goals, but in contrast to other natural resources, they are missing from the goals and targets. This Perspective explores why and examines the narratives that shape the role of minerals in development. We share the findings of global consultations conducted under the mandate of the United Nations Environment Assembly to strengthen international cooperation on mineral governance, and we introduce the concepts of ‘development minerals’, ‘mineral security’ and ‘mineral poverty’ to better integrate minerals into the Sustainable Development Goal agenda.

For Earth scientists working on issues of development, it is now commonplace to begin our talks and publications by reasserting that minerals are implicit to, or embedded within, each and every one of the 17 goals and 169 targets of the United Nations (UN) Sustainable Development Goals (SDGs)<sup>1–4</sup>. And while we agree with this sentiment and have started this Perspective that way, it is also true that the SDGs were formulated without explicit reference to minerals or earth materials.

The publication of *Transforming Our World: The 2030 Agenda for Sustainable Development*<sup>5</sup> followed a three-year process of consultation, summits and high-level political forums to define the post-2015 development agenda. The 15,000-word outcome report describes the SDGs and their constituent targets and maps in detail how humanity can achieve the “Future We Want”. Natural resources feature prominently across the report, with a strong recognition that the sustainable management of natural resources is an area of “critical importance for humanity and the planet”<sup>6</sup>. Despite this, the report does not refer to the words ‘mineral’, ‘mining’ or ‘miner’ (Table 1). Forests, fisheries, wildlife, pasture, energy, water, air and genetic resources are all referenced. Agriculture, water resource management and forest management are all described in detail. Farmers, herders, pastoralists and fishers all have a place in the agenda.

Target 2.3, for example, calls for a doubling of the incomes of small-scale farmers, pastoralists and fishers, while Target 14.b calls for small-scale artisanal fishers to have access to marine resources and markets. There is no equivalent reference to the fate of the world’s 40-million-plus artisanal and small-scale miners who also live in circumstances of poverty<sup>6</sup>.

## Minerals and the “Future We Want”

How could this be? How could minerals, one of the classic elements of nature so key to human existence, not be explicitly referenced in the global goals?

In 2013 and 2014, one of the authors of this Perspective was a member of the UN Sustainable Development Solutions Network Thematic Group on the Good Governance of Extractive and Land Resources. The role of this group was to provide technical advice on the formulation of the SDGs and the post-2015 development agenda. We prepared reports describing the fundamental role of minerals and their governance in sustainable development, and we formulated draft wording for goals and targets that included minerals, mining and miners for consideration by the various committees and panels crafting the agenda<sup>7</sup>.

One reason why we believe those arguments were ultimately not persuasive is that the stories that we tell as a society about minerals, mining and miners are told in predominantly one dimension: they are stories about irresponsible mining companies running roughshod over the environment and communities, as well as irresponsible artisanal and small-scale miners fuelling conflict, clearing forest and fouling rivers. This is understandable. These stories are based in fact, and we ourselves have cited plenty of examples<sup>8,9</sup>.

Narratives (and counternarratives) play an important role in shaping sustainability transitions<sup>10</sup>. When we are identifying which are the villains and heroes of our planet’s twin crises of environmental sustainability and global poverty, minerals are almost exclusively marked villain. The role that the mining of minerals has played in, for example, the colonization of nations and the creation of environmental problems is more visible and defining than the role that minerals have

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**Table 1 | References to natural resources in the SDGs**

Natural resources in the SDGs (number of mentions)	Highest mention
Resource: food (15), fisheries (5), fish (1), marine resources (5) Occupation: farmers (3), pastoralist (2), fishers (3), food producers (1), herder (1) Activity: farming (0), fishing (3), fish harvesting (1) Sector: agriculture (5), agricultural (6), aquaculture (1) Management: sustainable agriculture (5), sustainable management of fisheries and aquaculture (1)	SDG 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture SDG 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development Other mentions: Target 2.3, Target 14.4, Target 14.b Food security: explicit in SDG 2, implicit in the SDG vision (paragraph 7), explicit in the agenda (paragraph 24), implicit in process target (14.b)
Resource: forest(s) (9), wildlife products (1) Occupation: forester (0), local communities pursuing sustainable forestry livelihoods (1) Activity: deforestation (1), afforestation (1), reforestation (2), harvesting forests (0) Sector: forestry (0) Management: sustainably manage forests (3), forest management (1)	SDG 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss Other mentions: Target 15.2, Target 15.7, Target 15.b, Target 15.c Forest security: no explicit or implicit mention of forest security or access to forest products
Resource: water (18) Occupation: water harvester (0), local communities managing water (1) Activity: water pollution (4), water recycling (2), water collection (0), water harvesting (1), sustainable withdrawals of water (1), wastewater treatment (1) Sector: water utilities (0), wastewater utilities (0), water harvester (0) Management: water resource management (5), sustainably manage and protect marine and coastal ecosystems (1), sanitation management (1), desalination (1)	SDG 6. Ensure availability and sustainable management of water and sanitation for all Other mentions: Target 6.1, Target 6.3, Target 6.4, Target 6.5, Target 6.a, Target 6.b Water security: implicit in SDG 6, implicit in Target 6.1, implicit in the SDG vision (paragraph 7), explicit use of water scarcity in Target 6.4
Resource: air (4), gas (2) Occupation: none Activity: air pollution (1), gas emissions (2) Sector: none Management: air quality management (2), chemical release to air (1), sustainable use of air (1)	Declaration. A world in which consumption and production patterns and use of all natural resources—from air to land, from rivers, lakes and aquifers to oceans and seas—are sustainable Other mentions: Target 3.9, Target 11.6, Target 12.4 Air security: implicit access to clean air in Targets 3.9 and 12.4
Resource: energy (17) Occupation: energy workers/workforce (0) Activity: energy innovation (1), energy research (1), investment in energy infrastructure (1) Sector: energy services (3) Management: energy efficiency (3), sustainable energy (1), energy management (0)	SDG 7. Ensure access to affordable, reliable, sustainable and modern energy for all Other mentions: Target 7.1, Target 7.a, Target 7.b Energy security: implicit in SDG 7, implicit in the SDG vision (paragraph 7), implicit in the agenda (paragraph 27)
Resource: genetic (3) Occupation: farmers (3), pastoralist (2), fishers (3), food producers (1), herder (1) Activity: cultivate for genetic diversity (1) Sector: agriculture (5), agricultural (6), aquaculture (1) Management: soundly managed and diversified seed banks (1), traditional knowledge (1)	Target 15.6. Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed Other mentions: Target 2.5 Genetic resource security: implicit in Targets 2.5 and 15.6
Resource: mineral (0) Occupation: miner (0), quarry worker (0), artisanal and small-scale miner (0) Activity: mining (0), quarrying (0), extraction (0), rehabilitation (0), mineral processing (0) Sector: mineral industry (0), extractive industry (0), quarry industry (0) Management: sustainable mining (0)	Not referenced in the report or the goals and targets Mineral security: no explicit or implicit mention

Data from ref. <sup>5</sup>.

and continue to play in enabling our shelter, sustenance, transport, energy and communication. Minerals, according to this narrative, are an impediment to sustainable development, with their extraction negatively impacting the achievement of the SDGs. While the extraction of minerals does have this potential, the predominance of this narrative generates enormous stigma for the sector<sup>11</sup> and the people within it, and makes it difficult for those imagining a sustainable world to create a place in this utopia for minerals, mining and miners.

The act of extraction (mining) has long been the focus of the minerals story, in a way that the role of the resource itself (minerals) has not. Our collective global discussion about agriculture, by comparison, is as much about food as it is about farming, and we can consider the current fundamental unsustainability of global food production alongside the criticality of food security and the urgency to address malnutrition. In the same way, the intersections between mining, minerals and development, in all their complexities, are crucial to advancing sustainable development.

### The neglected minerals of development

A second reason, related to the first, is that the public understanding of the minerals sector bears little resemblance to the actual minerals

sector. Mostly, when we think about mining, we conjure images of big machinery and global trade. We picture gold, iron ore, copper, coal, gemstones and perhaps more recently commodities central to renewable energy transitions such as lithium and cobalt. We mainly think of big, multinational mining companies, or if we do think about small-scale mining, we think mostly about those panning for gold or fossicking for diamonds.

It is little known that metals in fact make up a minority of mineral production by volume and value<sup>12</sup>. The majority of mineral commodities are not exported, and large-scale, multinational mining companies are relatively minor players in global mineral production<sup>13</sup>. The vast majority of the minerals and materials that are mined for human use are barely noticed by society. Whether it be glass, roof tiles, bridges or roads, the public is largely unaware of the minerals that are their main ingredients.

Take the case of eggs, for example. The farming of chicken eggs, whether free-range organic or in a factory, requires the addition of limestone to feed so that chickens can consistently lay their calcite mineral shells. Limestone is also the main ingredient in toothpaste, and in fact the marble quarry in Carrara, Italy, from where Michelangelo cut his famous statue of *David*, sells much of its product for pharmaceutical

**Table 2 | Priority issues and options for action to strengthen international cooperation on minerals identified during global consultations conducted for UNEA 4/19**

Issue	Actions
Material intensity of recovery following the COVID-19 pandemic	There is a need for urgent dialogue on the role of mineral resources in ‘building back or recovering better’ following the COVID-19 pandemic. That dialogue could be enhanced through parallel efforts to consider: (1) The role of the minerals sector, especially construction materials, in disaster recovery and planning (2) The strengthening of the technical and sustainability standards of development banks for the sourcing of construction materials, including sand.
Platforms for cooperation and capacity building	(1) Continuing cooperative dialogue on the sustainable development of minerals and metals to identify priorities for future action and advance specific themes. (2) Expanding and regionalizing existing forums through wider participation to include environment and mining ministries; ministerial-level representation and engagement; partnership with regional economic communities; and enhanced dialogue between producers, financiers and consumers. (3) Multi-stakeholder dialogue and governance initiatives to set minimum standards, which should take a holistic and human rights approach and consider effective transparency and accountability aspects, and may include options for legal remedies and minimum standards for community benefit-sharing. (4) Establishing a funding mechanism to scale up capacity building, knowledge-sharing and cooperation between member states and other stakeholders in mineral resource governance.
Tailings management	(1) Advancing the establishment of an independent entity to oversee, support and provide assurance on the implementation of the standard. (2) Encouraging and prioritizing the decommissioning, removal and rehabilitation of unsafe facilities, in particular those with no responsible owner. (3) Promoting continued cooperation among UN agencies and relevant stakeholders to strengthen tailings governance and to collate and commission further research on innovations in tailings management, reduction, recycling and reuse, in particular the potential to reuse ore-sand (the crushed stone produced as a by-product of the processing of mineral ores) before it becomes tailings as an alternative to natural aggregate in the construction and land reclamation sectors, and to further develop the Global Tailings Portal to expand access to information.
Harmonization and alignment of governance initiatives	(1) Dialogue between member states and partners on potential avenues for mainstreaming existing voluntary initiatives into national laws and regulatory instruments. (2). Collaborative initiatives for capacity building, focusing on ‘building from below’ to reduce power asymmetries at the supply base. (3) Development and implementation of a harmonized approach to auditing existing governance initiatives to enhance efficiency and coherence. (4) Sharing of information to enable consumers, shareholders and other stakeholders to make informed decisions.
Artisanal and small-scale mining	(1) Encouraging relevant state and non-state actors to enact and adapt to the local context the Mosi-oa-Tunya Declaration on Artisanal and Small-Scale Mining, Quarrying and Development. (2) Encouraging states and other stakeholders to conduct research and share knowledge regarding the scale and geographic extent of the artisanal and small-scale mining sector through country-wide censuses. (3) The international community should investigate the development of a standard similar to the Equator Principles to support the financing of artisanal and small-scale mining for transformation and to investigate options for strengthening artisanal and small-scale mining associations at the international level.
Mine waste recycling, reuse and circularity	Further research and policy actions on mine waste and circularity could include the recycling and reuse of tailings and other mine wastes and by-products, re-mining and re-processing of wastes (including from artisanal and small-scale mining), reuse of demolition waste and incorporation of waste reuse options in mine planning and closure planning.
National-level governance	Legal reforms may contribute to supporting sectoral transformation by adopting laws and policies that include aspects of public participation, remedy and redress, transparency, trade agreements, value chain and linkage development, private-sector controls, anti-corruption efforts and long-term environmental liability. In many cases, support is needed for the implementation of existing legal frameworks and to enhance capacities to monitor compliance with these provisions. Legal frameworks should extend to minerals that are mined or quarried, processed and used domestically, which are often referred to as development minerals.

Data from refs. 23–30.

use. There are Europeans who are literally brushing their teeth with the marble of *David*.

Because the public imagines the minerals sector as the large-scale mining of metal ores, which indeed are renewed slowly, it neglects to imagine that many minerals are renewed at time scales more similar to that of timber. Such minerals include halite (salt), calcite and even the apatite that we grow as our teeth.

The most important mineral commodity as a function of volume and value is actually sand<sup>13–16</sup>. Estimates of global sand, gravel and crushed stone production (collectively known as aggregate) are in the vicinity of 50 billion tonnes per year, which is a staggering 6.25 tonnes per person per year, making it arguably the most utilized natural resource after water<sup>15</sup>. Most of this aggregate is crushed stone, but natural sand represents a sizable fraction, including sand sourced from rivers and the marine environment. To help visualize the scale of the sector, the total historic production of gold roughly fits into just three Olympic-sized swimming pools<sup>17</sup>. The yearly production of sand, gravel and crushed stone would not fit into ten million Olympic-sized

swimming pools. And it is not just sand: eight of the top ten produced commodities are industrial (non-metallic) minerals or construction materials, which total more than 80% of global mineral production. Metals represent less than 3%<sup>13</sup>. Yet, almost all the research, policymaking and development programming on minerals and mining are about metals, energy minerals or precious stones.

Metals of course create greater societal value than their production volume would suggest, and their extraction generates large volumes of mineral waste. Nevertheless, the value and the volume of industrial minerals and construction materials are both larger and underappreciated. In the United States, for example, the value of metals production was US\$33.8 billion in 2021, whereas that for industrial minerals and construction materials was US\$56.6 billion. Crushed stone was the leading commodity by value at US\$19.3 billion, which was almost double the value of the leading metal commodities, copper (US\$11.8 billion) and gold (US\$10.5 billion)<sup>12</sup>.

The narrow framing of the mining industry as exported minerals has implications not only for the way the SDGs are formulated but

**Table 3 | Priority issues identified by global consultations conducted for UNEA 4/19 by region**

	Material intensity of COVID-19 recovery (42/111 submissions, including 13 governments)	Cooperation and capacity-building platforms (45/111 submissions, including 16 governments)	Tailings management (50/111 submissions, including 18 governments)	Harmonization and alignment of governance initiatives (53/111 submissions, including 23 governments)	Artisanal and small-scale mining (52/111 submissions, including 22 governments)	Mine waste recycling, reuse and circularity (34/111 submissions, including 16 governments)	National-level governance (48/111 submissions, including 14 governments)
Africa	•	•	•	•	•		•
Asia and the Pacific	•	•	•	•	•	•	•
Europe and Caucasus	•	•	•	•	•	•	•
Latin America and the Caribbean	•	•	•	•	•		•
North America		•	•	•			•
West Asia		•	•	•		•	•

Data from refs. 23–30.

also for global development itself. Millions of people are involved in the mining and quarrying of local industrial minerals (such as gypsum and salt) and construction materials (such as sand, gravel, limestone and granite). And billions of people rely on these commodities for the basic ingredients of their lives.

While working at the UN Development Programme, authors of this Perspective along with colleagues<sup>13</sup> coined the term ‘development minerals’ to describe minerals and materials that are mined, processed, manufactured and used domestically in industries such as construction, manufacturing, infrastructure and agriculture—and to recognize their positive potential. In comparison with exported mineral commodities, development minerals have closer links to local economies with more direct impacts on poverty reduction. This is not to say that mineral exports are not relevant to development, just that much of the supply chain from extraction to use is not captured locally, and the minerals (and the utility they provide) are mostly destined for consumers in developed countries. The quarrying of development minerals is dominated by informal miners and small- and medium-scale domestic businesses, and it suffers a series of environmental, social, health and safety, and labour rights challenges that are partly due to the sector’s neglect. Industrial minerals and construction materials have previously been described by economic geologists as ‘low value minerals and materials’, and while they may be low value to international commodity markets, they are fundamental from the perspective of local and domestic development.

The introduction of the term ‘development minerals’ has given more visibility to the role minerals play in poverty reduction and opened up new domains of development focus. It has inspired work on the sustainable sourcing of aggregate for infrastructure, the consideration of construction materials in disaster planning and resilience, and support to build the capacity of informal and formal small and medium-sized quarry enterprises. Development projects have included the use of local cobblestones for paving previously unsealed rural roads as a food security strategy to preserve transport routes during the wet season, support for internally displaced people from armed-conflict regions to reconstruct houses and clinics with thermally efficient soil-stabilized bricks instead of imported concrete blocks<sup>18</sup>, the introduction of low-carbon concretes made from local materials, and the use of local crushed rocks as a soil amendment for agriculture<sup>19</sup>, among many others. The term has also now been adopted in a range of national, regional and international frameworks and declarations, including those of the African Union, the UN, the Organisation for Economic Co-operation and Development and the World Bank.

### Strengthening cooperation on minerals

There is an appetite among UN member states for greater international cooperation on the topic of mineral governance<sup>20</sup>, even in the absence of clear guidance from the SDG framework and coordinated global goals and targets related to minerals. Such cooperation builds on the UN’s role in the establishment of a range of key governance initiatives with relevance to the minerals sector and discussions that have featured across UN conferences on sustainable development<sup>21</sup>.

At the fourth session of the UN Environment Assembly (UNEA) (the principal global decision-making body on the environment), which was held in Nairobi, Kenya, on 11–15 March 2019, UN member states adopted UNEP/EA.4/Res.19 on Mineral Resource Governance<sup>22</sup>. The resolution requests the UN Environment Programme (UNEP) to collect information on sustainable practices, identify knowledge gaps and options for implementation strategies, and undertake an overview of existing assessments of different governance initiatives and approaches relating to sustainable management of metal and mineral resources.

Authors of this Perspective worked with UNEP to undertake global consultations with UN member states and other stakeholders<sup>23</sup>. Twenty-three consultative meetings were held between July and November 2020, during which 1,280 people from 123 countries shared knowledge, challenges and good practice examples related to mineral resource governance. A further 111 written submissions were received from stakeholders from 61 countries (including government officials from 37 member states).

The consultations revealed a range of priority areas that found broad agreement across regions and provided the basis on which recommendations and suggested actions were presented for consideration by the UNEA (Tables 2 and 3)<sup>23,24</sup>. Summary reports capturing regional variations were published for each region<sup>25–30</sup>. The priority areas include the material intensity of recovery following the coronavirus disease 2019 (COVID-19) pandemic; platforms for cooperation and capacity building; tailings management; harmonization and alignment of governance initiatives; artisanal and small-scale mining; mine waste recycling, reuse and circularity; and national-level governance reform.

The concept of development minerals helped widen the conversation beyond the traditional domains of metals, energy minerals and precious stones. Sand sustainability featured prominently, bolstered by UNEP reports on the topic<sup>15,31</sup>.

On the basis of this work, UN member states in March 2022 adopted resolution 5/12 on ‘Environmental aspects of minerals and metals management’, which asks UNEP to convene consultations that feed

**BOX 1**

## Issues for consideration in assessments of mineral security

**Shelter.** The affordability, accessibility and diversity of construction materials (especially in high-demand situations such as disaster reconstruction) impact the quality and cost of homes and buildings. Options include diversifying local production of building materials, supporting vernacular architecture and better integrating minerals into disaster planning such as post-disaster needs assessments. Pacific small island developing states, for example, currently face extremely high prices for imported Portland clinker (the precursor of cement), which is severely limiting housing and infrastructure development.

**Green industrialization.** The high price of mineral-based imports and the underdeveloped domestic extraction and beneficiation of industrial minerals limit and hinder structural transformation. Options include the substitution of key imports and building green industrialism around domestic industrial mineral production.

**Energy.** Energy security is undermined by out-of-reach prices for imported mineral products such as solar panels, wind turbines, and lithium and cobalt batteries. Substitutes for high-carbon-emissions Portland cement are available from the calcination of local clays, cementitious mineral wastes (such as fly ash or slag) or the use of geopolymers.

**Water and climate adaptation.** Sustainable sources of aggregate for construction, land reclamation and coastal protection are needed to replace what is currently sourced from dynamic environments such as rivers, lakes and the ocean, with consequences for access to clean water.

**Transport.** The high construction and maintenance costs of imported asphalt limit the extent to which roads can be sealed. Alternatives include locally produced cobblestones and pavers. Increasing demand for sand, gravel and crushed stone, besides the impact on dynamic ecosystems, creates supply and affordability challenges to the construction of vital infrastructure.

**Sustenance.** The limited availability and high costs of mineral fertilizers and soil conditioners for agriculture disadvantage small producers. In Brazil, farmers have turned to local crushed stone as an alternative to strengthen food security<sup>19</sup>. These soil amendments have also been shown in some cases to remove atmospheric carbon dioxide<sup>41</sup>. Agriculture and mining are linked in other ways with many artisanal and small-scale farmers and miners practising both mining and farming as a livelihood diversification strategy.

into a global intergovernmental meeting, with the aim of developing proposals to enhance international cooperation and the environmental sustainability of minerals in line with the 2030 Agenda for Sustainable Development<sup>32</sup>.

### Towards the post-2030 SDG agenda

Part of the challenge of integrating minerals into sustainable development and the framework of the SDGs is to offer clear concepts that include the totality of minerals contribution or that articulate the links

to poverty reduction and human development. Earlier we introduced the concept of development minerals and how this concept can help make obvious the links between the local minerals and materials and local development, as well as bring those links to the forefront of global conversations about sustainable development.

Another feature of the public discourse on minerals, when compared with other natural resources, is that access to mineral supply is almost never discussed from a human-centred perspective. In Table 1, we identified that a major part of the framing of natural resources in the SDGs relates to their fair and affordable access for development, with explicit or implicit reference in the goals and targets to food security, energy security and water security.

The issue of access to minerals for development has so far predominantly been framed through the lens of criticality. Critical minerals refer to metallic and non-metallic elements that are essential for the economic and national security of states, especially advanced manufacturing and technology, and that are at risk of supply chain disruption or, by some measures, also have substantial environmental impacts associated with extraction<sup>33–35</sup>. The reference point for which criticality is defined is the state, the security being sought is mineral supply for defence and industry, and the most common elements identified as critical are rare-earth elements, platinum group metals and indium<sup>34</sup>. Businesses too have applied the concept to understand potential disruptions to their own supply chains. Critical minerals as a conceptual frame helps states (and businesses) to plan for their economic development but falls short if our concern is human-centred where access is considered from the reference point of the local availability of minerals for the basics of human development.

In the case of agriculture, academics, practitioners and policymakers have been successful at expressing the clear and unequivocal link between the availability of food and human development, defining food security first as the availability of basic foodstuffs<sup>36</sup> and later as existing “when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”<sup>37</sup>.

To amplify the links between minerals and development, here we introduce the concepts of mineral security and mineral poverty. We define mineral security to exist when all people have sufficient and affordable access to the minerals necessary for human development, including for shelter, mobility, communication, energy and sustenance. Mineral security also implies access to the beneficiation and transformation necessary to turn minerals into usable commodities. Mineral insecurity is most acutely, though not exclusively, experienced in circumstances of poverty. The lack of access to the minerals necessary for development is both a contributing factor and a consequence of poverty. We refer to mineral poverty as a state of mineral insecurity associated with poverty. Mineral poverty may limit access to vital infrastructure and services such as housing, transport and energy, and is interconnected with the other material dimensions of poverty.

Mineral security and mineral poverty are not terms that are currently in wide use. A literature search revealed the phrase ‘mineral security’ in just 10 publications, compared with 46,535 for food security (Web of Science; 25 May 2022), with few prior definitions of the term. In all prior uses, and like the term ‘critical minerals’, mineral security has been used in the context of a state’s quest to secure critical supplies for defence and industry<sup>38–40</sup>. A literature search for the phrase ‘mineral poverty’ revealed no results (Web of Science; 25 May 2022).

Assessments of mineral security, especially in the context of mineral poverty, might be usefully conducted at multiple scales and integrated into the national development planning process or into baseline assessments for development programming. Assessments might cover a wide range of issues (Box 1).

As is clear from Box 1, there are strong interlinkages between food, energy, water and mineral security that are worthy of greater investigation, even more than what has already been mapped by those exploring

the relationships between mining and the existing SDG framework<sup>1–3,16</sup>. Aided by the concepts of development minerals, mineral security and mineral poverty, we believe that new understandings about development, new actors and new pathways for sustainability transitions can be identified, and alternative narratives will ultimately emerge to better communicate the essential role of minerals.

Ahead of us now lies the task of utilizing these new concepts in such a way that minerals are a more central feature of the post-2030 development agenda and any revised formulation of the SDGs. We will not pre-empt here the formulation that UN member states should settle on, whether it be the inclusion of a stand-alone goal or one that is integrated with other natural resources. However, we advocate taking advantage of the opportunity to build consensus during the implementation of the UNEA 5/12 resolution to activate these new concepts and build on the innovations in practice that they may usher in. Minerals and mining have enormous capacity to both enable and undermine the achievement of the SDGs. Our task is to make clear why minerals are worthy of inclusion in the “Future We Want”.

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## Author contributions

D.M.F., J.K. and D.H. conceptualized the paper, performed the analysis, wrote the original draft, and reviewed and edited the paper. D.M.F. and J.K. worked with UNEP to convene global consultations on mineral resource governance.

## Competing interests

The authors declare no competing interests.

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