Centre for Social Responsibility in Mining
11 December 2020

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Mining regions in transition – a global scan – TECHNICAL REPORT

Report for the Social Aspects of Mine Closure Research Consortium

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Acknowledgements

This technical report is a supplement to the study *Mining regions in transition – a global scan,* which is part of a broader initiative, the Social Aspects of Mine Closure Research Consortium. Established in 2019, the consortium is a multi-party, industry-university research collaboration challenging accepted industry norms and practices around mine closure and demanding new approaches placing people at the centre of closure. Industry partners in the consortium include: Anglo American, BHP, MMG, Newcrest, Newmont, OceanaGold and Rio Tinto. The initiative falls under the SMI's Transforming Mine Lifecycles cross-cutting program.

The graphical representation of our research process (Figure 1), RESET analytical framework (Figure 7) and the Table 3 icons were designed by Darren Sprott, Design Solutions Australia.

Citation

Everingham, J., Svobodova, K., Lèbre, É., Worden, S. & Owen, J. R. (2020). *Mining regions in transition – a global scan. Technical report.* Centre for Social Responsibility in Mining. University of Queensland: Brisbane.

Cover image

The Brañany municipality in close proximity to the Bílina coal mine, Czech Republic. Photo courtesy of Marketa Hendrychova.

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

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

List of symbols and abbreviations

Abbreviation	Definition
>	Greater than
≥	Greater than or equal to
<	Less than
%	Per cent
$/km^2$	Per square kilometre
Bt	Billion tonnes
GADM	Database of General Administrative Areas
GHM	Global Human Modification
HDI	Human Development Index
JORC	Joint Ore Reserves Committee
km	Kilometres
MCI	Mining Contribution Index
MRITs	Mining regions in transition
Mt	Million tonnes
R&Rs	Reserves and resources
RESET	Regional Economic, Social and Environmental Transition
RGI	Resource Governance Index
t	Tonnes
WGI	Worldwide Governance Index

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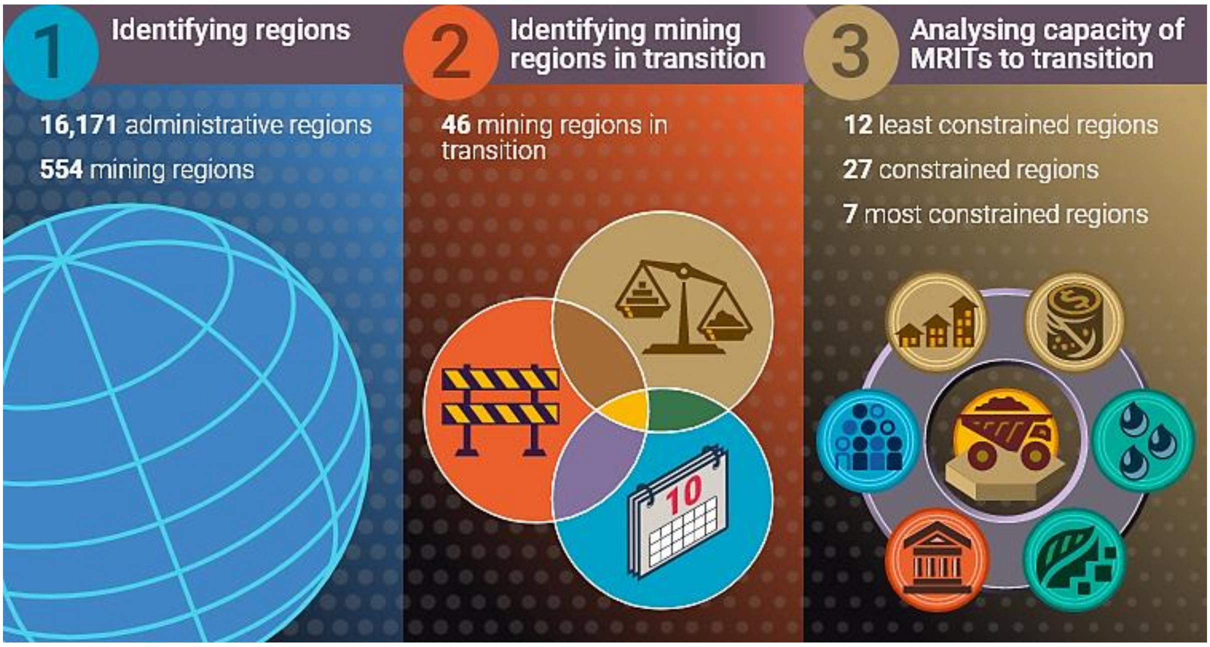
1. Introduction to the research and technical report structure

The study of *Mining regions in transition – a global scan* determined the location of the world's mining regions by applying clear, consistent approaches to defining those regions. This report presents the reasoned process adopted for identifying, analysing and comparing the capacity of mining regions to transition through the final stages of the mining lifecycle. The three-step process is illustrated in Figure 1.

Figure 1: Main steps of the research to narrow focus and allow progressively greater insight



This technical report's main sections are described below:

- Section 2 has three subsections corresponding to the three steps outlined in Figure 1. Each subsection provides working definitions, concepts and methods applied at that step. The sequence is 'mining regions', 'mining regions in transition' (MRITs) to closure and 'capacity to transition'.
- Section 3 provides supplementary data and descriptive statistics of the 46 MRITs identified in the study. The section expands on the summary details provided in the main report.
- Section 4 briefly notes methodological contributions of the study.
- Section 5 provides details of the data sources that were central to the research.

2. A three-step research design

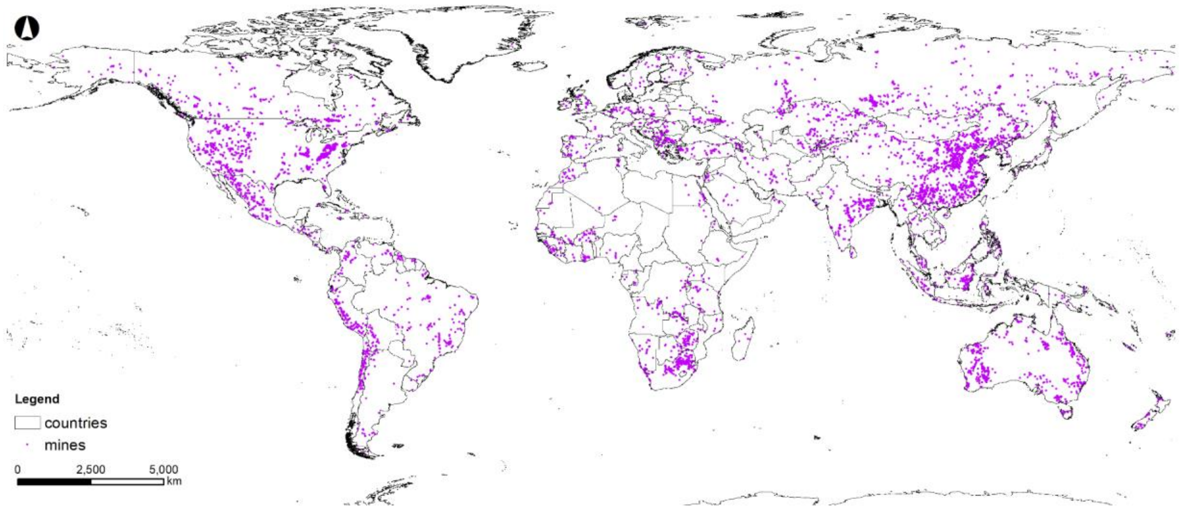
2.1 Defining and locating global mining regions

The initial step in this global scan was to define and locate the world's mining regions. This study defines a mining region as '**a geographical region administered by a single government entity and where at least three operating and/ or closed mines within 50km of each other form a dense mine cluster'**. This definition required overlaying administrative regions with mine clusters by identifying a sequence of locations and boundaries.

Global mining sites

Mining regions were identified by analysing the location and density of mines (cluster distribution) within global administrative regions using data from the S&P Global Market Intelligence database.[2] The S&P database defines a 'mine' as a single operation including all pits and shafts within one mining property. To systematically locate key mineral production sites, we removed mines in the preproduction stage, those without status information and those without XY coordinates listed in the database. This initial selection process led to a sample of 8,555 mines from a total 35,610 mines. The geo-location of each of mine in the sample is a point with XY coordinates (Figure 2).

Figure 2: Global distribution of 8,555 mines selected for identifying mining regions in transition (MRITs)



Mine clusters

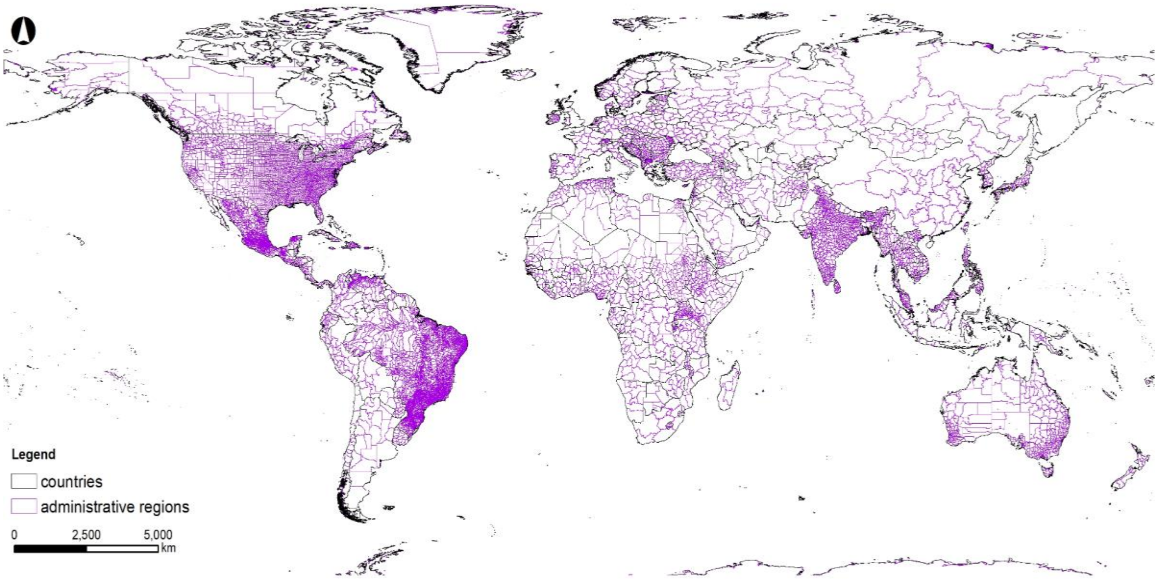
By spatial clustering of mine locations, we determined the density and intensity of mining activities. To identify mine clusters, we measured the distance between mines using the 'Near function' in ArcGIS. A 50km distance was adopted as a threshold value for higher density of mines, and 7,234 mines were located within this threshold with the average distance between mines being 26.67km.

[2] The S&P Global Market Intelligence database relies on public disclosure, which results in some skewing and limitations of data. For instance, historical and mine size data may be incomplete. Artisanal and small-scale mining or some state-owned projects and other unreported mining activities are typically not covered by this database. Projections about mine stages and closure may prove inaccurate. In addition, there are gaps in data, e.g. only 50% of entries include information about closure dates.

Boundaries of administrative regions

To identify administrative regions and their geographical boundaries, we used a dataset of global administrative areas, known as GADM.[3] The dataset provides boundaries of 386,735 administrative jurisdictions at multiple levels and with variable sizes. The administrative levels are reported in a sequence of non-overlapping geographic areas and vary on a country basis from national, state/ province, regional to local levels. Sub-country or sub-province levels were adopted as an administrative region assumed to have consistent regulation and functional governance. This selection procedure identified a sample of 16,171 administrative regions with clearly defined boundaries (Figure 3).

Figure 3: Administrative regions as identified in the GADM dataset of global administrative areas.



[3] The Database of Global Administrative Areas is a high-resolution database of the location of country administrative areas, that aims to cover all countries, at all levels, and at any time period. It is maintained by the American Association for the Advancement of Science (AAAS) https://www.aaas.org/programs/scientific-responsibility-human-rights-law/global-administrative-areas and located at https://gadm.org/index.html

Locations of global mining regions

To identify administrative regions with a higher density of mines to match our definition of 'mining regions', we combined locations and information on mines from the S&P Global Market Intelligence database with boundaries and information from GADM. To select only those administrative regions that have ≥3 mines within 50km of each other, we used *Spatial Join* and *Select by attributes* tools in ArcGIS and derived the final sample of 554 mining regions (Figure 4). This process eliminated 15,044 of the world's administrative regions that have no mines in 50km clusters and 573 others that have only one or two mines in this proximity. There is a trend across the mining regions for the number of regions with large clusters to decrease (Table 1). Only 13 mining regions have a cluster of more than 70 mines.

Figure 4: Global distribution of mining regions

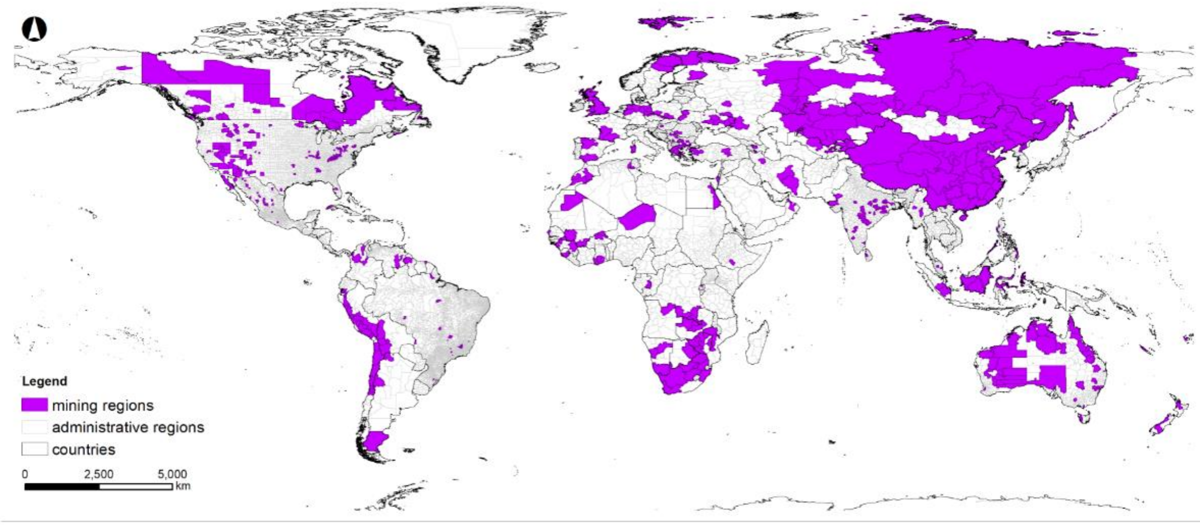


Table 1: Distribution of mines within 50km proximity of each other across 16,171 administrative regions (Mining regions are those in the shaded columns)

Number of mines within 50km of others	0	1-2	3-20	20-70	70-212
Number of administrative regions with specific number of mines close together	15,044	573	491	50	13

2.2 Defining and locating mining regions in transition (MRITs)

In Step 2, we defined MRITs as **'mining regions that have a significant proportion of closed mines and of mines approaching closure and that also host significant mineral reserves and resources'**.

We analysed the data sourced from the S&P database for the 554 mining regions using basic descriptive statistics in MS Excel, including minimum, maximum, average, mode and median. We corrected for missing data and zero values.

To identify MRITs, we applied three selection criteria to the data in MS Excel (Figure 5):

1. Regions where the percentage of closed mines is equal to or above the median value of the 554 mining regions, the median value being 20% of reportedly closed mines in the region. A closed mine is one where operations have ceased and there has been a formal closure process. A significant proportion of closed mines is indicative of a mature mining region and that a possible regional transition to closure is under way (51% of the 554 mining regions meet this criterion).
2. Regions where the percentage of mines with projected closure dates within the next 10 years is equal to or above the average value of the 554 mining regions, the average value being 13%. This criterion indicates that preparation for mine closure is progressing but that there are more closures to come. When a significant proportion of mines are reaching closure across a region, governance actors need to implement transition planning at the regional level (40% mining regions qualify).
3. Regions with high reserves and resources (R&Rs), indicate mining sector significance and hence a threshold of >279Mt was applied as that represents R&Rs above the regional median value. These regions have larger mine footprints and potentially face greater adverse impacts than the small and marginal mining regions eliminated. Consequently, they are likely to require more resources and technical capability to manage their transition (46% mining regions meet this criterion).

Figure 5: Combination of three factors to define mining regions in transition.

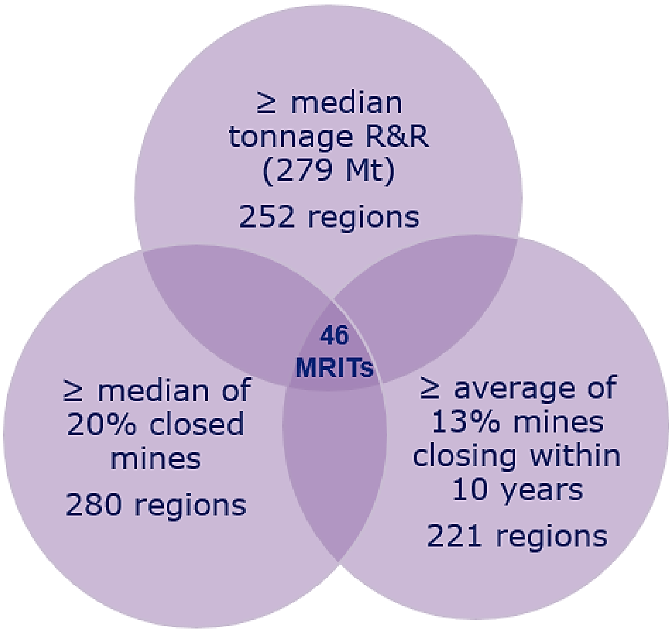


Figure 5 is a graphical representation of the relationship between the three criteria outlined above. Forty-six mining regions (8% of the sample) meet all three criteria (see the central overlap area in the figure). We define these regions as MRITs.

Table 2 presents the threshold values for each criterion and compares the MRIT thresholds with those for all mining regions.

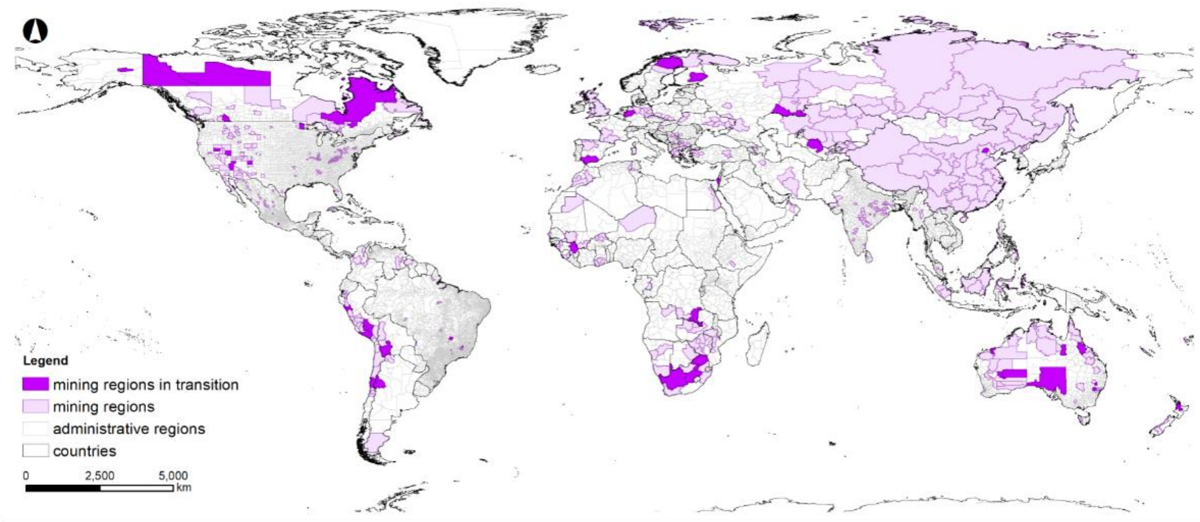
Table 2: Characteristics of 46 mining regions in transition in comparison to all 554 mining regions. Shaded cells show the threshold values applied for the selection criteria.

	Intensity of mining (Mt of reserves and resources)		% Closed mines		% Closing in 10 years	
	MRITs	All mining regions	MRITs	All mining regions	MRITs	All mining regions
minimum	296	0.04	20	0	13	0
maximum	26,919	72,634	75	100	75	100
average	2,234	2,239	36	25	29	13
median	776	279	33	20	25	0

The MRITs identified are located on all inhabited continents (Figure 6). Using the MS Excel function *SUMIF*, we summarised information on mines for each of the 46 regions that share these attributes, and prepared a table where each row provides information on the number and percentage of mines with particular characteristics in the region (e.g. closed, closing in 10 years, large mines, primary commodities produced). An extract of this data is provided in Table 5 (Section 3.1). This summary provides insights into the comparative nature and circumstances of the MRITs and their capacity to transition.

The global distribution and characteristics of all 46 MRITs are represented on satellite images available here where a link to 3D representations of the regions uses Google Earth as an entry platform. This site allows users to explore high-level data about each region and view their landscapes from various angles.

Figure 6: Global distribution of 46 mining regions in transition



2.3 Defining and determining capacity of regions to transition

We defined regional capacity to transition as '**the dynamic, multidimensional capability of a region to harness or adapt regional assets, while cultivating new competencies that enable the region to survive and prosper even as mining activity changes'**. To examine this capacity empirically, we formulated an analytical framework – RESET – to guide our work.[4] RESET incorporates socio-economic, environmental and governance dimensions – key pillars of sustainability (Figure 7). We added a demographic dimension to capture remoteness from population centres, another contextual factor that influences transition capacity. The framework also reflects the interconnections and influence of these factors on closure transition and the ways they combine with the mining practices in the region.

Figure 7: RESET, an analytical framework to diagnose capacity of mining regions to transition. The RESET framework consists of four dimensions and six contextual factors.

The suite of contextual factors that could be examined to assess transition capacity is vast. Some contextual factors point to greater capacity for mining regions to transition and to the nature of challenges likely to be confronted during the journey to a post-mining future. These factors were the focus of our global scan. Where possible we looked beyond national-level aggregated data to understand region-specific contexts. Data sources were not always available at a regional level and so, in some cases, national indicators were extrapolated to the regional level. By combining both region-specific and national data, we captured both inter- and intra-regional influences and the extent of influence. We used a combination of composite and cumulative indexes and disaggregated data. Disaggregated data is more specific and richer but quickly proliferates. Indexes are more general and they encompass and recognise multiple relevant contextual factors. We selected six high-level factors based on the availability of public data sources that have enough international coverage to permit a global scan.

[4] RESET is an acronym for regional economic, social and environmental transition.

Two socio-economic factors were considered in the analysis – level of development and dependence on mining. The level of development was measured using the UNDP's Human Development Index (HDI), which establishes a national average of human development achievements with respect to three socio-economic indicators: education, health and income. High human development signals high transition capacity. The International Council on Mining and Metals (ICMM)'s Mining Contribution Index (MCI) was used to measure dependence on mining. The MCI indicates the relative importance of mining to the economic life of a nation; high MCI means high mining dependence and lower transition capacity.

Composite and cumulative data were used for the environmental dimension focusing on water risk and environmental modification. The overall water risk data in the Aqueduct Water Risk Atlas comprises three groups of indicators: water quantity, water quality and reputational and regulatory risks. Human modification (GHM) is a cumulative score based on modelling the physical extent of anthropogenic land uses, including human settlement, agriculture, transportation, mining, energy production and infrastructure. Extensive human modification occurs in urban and agricultural areas. While mining modifies the landscape, its comparatively smaller footprint may not significantly contribute to region-wide human modification scores. Nevertheless, no assumptions are made that the pre-mining land use can resume unimpeded. High water risk and a highly modified environment both serve as constraints to transition capacity.

The quality of governance assessment uses the World Bank's Worldwide Governance Indicators (WGI), a composite measure at a national scale. WGI scores a country's governance according to six measures: control of corruption, government effectiveness, political stability and absence of violence/ terrorism, regulatory quality, rule of law, voice and accountability. High quality governance indicates high transition capacity. Where available, we also note the Resource Governance Index (RGI) scores which provide less complete, but more mining-specific data.

In the demographic dimension, remoteness of mining regions is assessed using population density as a proxy measure; the lower the population density, the more remote the region. A remote and sparsely populated region often has a low transition capacity due to the limited human resources available. More urbanised regions are more closely settled with a larger pool of human capital and often more infrastructure and more diversified economies to increase the range of options.

The world's mining regions have varied local and regional economies, social composition, locations and environment. These contextual factors represent a range of points along a continuum. For example, dependence on mining ranges from less dependent to very dependent. To categorise the MRITs into mutually exclusive binary possibilities for these contextual factors, we applied thresholds based on the scores stipulated by the data source (Table 3). These ratings illustrate comparisons and relative differences, rather than absolute 'tipping points' and, frequently, there are values close to the margins of categories. Therefore, we stress the spectrum or continuum of scores on these factors and the fact that our categories are indicative, rather than conclusive.

Table 3: Dimensions, contextual factors, data sources and thresholds of transition capacity

Dimension	Contextual factors influencing transition capacity	Data sources	Thresholds		Tier 1 Total number of regions =12	Tier 2 Total number of regions =27	Tier 3 Total number of regions =7
			Original scores	Our rating			
Socio-economic	Level of development	UNDP's Human Development Index (HDI)	0 – 0.549 (Low) 0.55-0.699 (Medium)	Less developed	0	0	7
			0.7 – 0.799 (High) 0.8 – 1 (Very high)	Developed	12	27	0
	Dependence on Mining	ICMM's Mining Contribution Index (MCI)	80+ (Very high) 60-79 (High)	Dependent	3	25	7
			40-59 (Medium) 20-39 (Low) 0-19 (Very low)	Less dependent	9	2	0
Environment	Risks to regulation, quality and quantity of water	Aqueduct Water Risk Atlas – composite water risks at catchment level	0-1 (Low) 1-2 (Low-medium)	Low risk	12	7	1
			2-3 (Medium-high) 3-4 (High) 4-5 (Extremely high)	High risk	0	20	6
	Extent of modification of natural environment	Cumulative Global Human Modification (GHM)	0-0.1 (Low)	Low modification	12	6	1
			0.1-0.4 (Moderate) 0.4-0.7 (High) 0.7-1 (Very high)	High modification	0	21	6
Governance	Quality of national governance and regulation	Composite Worldwide Governance Indicators (WGI)	<23.85 (Very low) 23.9-41.37 (Low) 41.38-60.29 (Medium)	Less satisfactory	0	11	7
			60.34-70.99 (High) >71 (Very high)	Satisfactory	12	16	0
Demography	Remoteness	2015 residential population density from CIESIN	<10/km^2 (Very low) 11-150/km^2 (Low)	Rural	12	24	6
			>150/km^2 (Medium-high)	Urban	0	3	1

A matrix approach was used to categorise the 46 MRITs into different configurations of contextual factors and thresholds, resulting in 64 configurations or groups. Forty-six configurations did not match any MRITs, leaving 18 groups of MRITs. We further categorised the remaining 18 groups into three broad categories, which we have called **tiers**, each with different capacity to transition (Table 4). For example, MRITs that are developed, less dependent on mining, with largely untouched environments and sound governance were considered to be the least constrained and have the most favourable factors for transition. MRITs that are less developed, dependent on mining, have environmental challenges and less satisfactory governance were considered to be the most constrained and have the least favourable factors for closure transition. The remaining MRITs are somewhat constrained with a somewhat favourable configuration of contextual factors. The analytical designation of tiers does not imply some regions will automatically succeed and others fail. Rather, it identifies relative capacity of regions and regions that may warrant more strategic and policy attention and support through the transition.

Table 4: Result of matrix process of grouping various combinations of contextual factors

Contextual factor	Tier 1 12 regions	Tier 2 27 Regions	Tier 3 7 Regions
Level of development	All high HDI	All high HDI	All medium or low HDI
Mining dependency	3 dependent, others moderate	All but 2 are dependent	All dependent with 3 > 80%
Water risk	All low risk	20 with high water risks	6 with high water risks
Modification of the natural environment	Largely intact environment	21 with highly modified environments	6 with highly modified environments
Governance	All satisfactory governance	11 with governance constraints	All less satisfactory governance
Capacity to transition	Least constrained Most favourable	Somewhat constrained Somewhat favourable	Most constrained Least favourable

Data from S&P database and the sources listed in Table 3 were used to characterise MRITs. The analysis identified patterns of contextual factors that can inhibit or enable transition capacity. The analysis compared the transition capacity of three tiers of mining regions with combinations of factors that are particular (though hardly unique) to three common mining contexts.

3. Characteristics of MRITs

MRITs have diverse characteristics some of which we captured through the three criteria and six contextual factors used in our analysis. The details we examined are by no means exhaustive but they illustrate the complex configurations of contextual factors that influence a region's transition capacity. We report these configurations as Tier 1, 2 or 3 mining regions, representing progressively greater constraints (Table 4).

This section highlights the diversity of characteristics. Relevant details on each region are provided in Section 3.1 (Table 5) including:

- Region name and national location.
- Intensity of mining – both the number of mines in the region and the % clustered.
- Mine closure – the number and % of closed mines and of mines closing in <10 years.
- Level of development – HDI score and ranking (low to very high).
- Dependence on mining – MCI value and rating (dependent, moderately dependent or low dependency). The direction and amount of change in this value between 2016 and 2018 is also provided to indicate the trend in mining dependency. The RGI rank and rating is given if available for national mining governance.
- Water risk – overall rating (low, low-medium, medium-high, high, extremely high) and three sub-measures for regulation, water quality and water quantity.
- Environmental modification – GHM value and rating (low, moderate or high).
- Governance quality – WGI score plus rating (very low to very high).
- Remoteness – population per km^2 with a low <10/km^2 being remote, medium <150/km^2 being rural, and >150/km^2 being urban.

Many other contextual factors influence capacity to transition and warrant consideration. Data on three of these that are specific to the mining context are included in Table 5:

- The prevailing commodity mined in the region (including the number and % of mines in the region extracting that commodity. This alerts stakeholders to commodity-specific closure challenges.
- The % and number of large mines (>100Mt of R&Rs) in the region. In terms of future land use options and economies, closure of large mines is more significant than smaller ones.
- The prevailing mining method including the number and % of mines in the region using that extraction method. Different extraction methods pose different closure requirements.

3.1 Supplementary data

Table 5: Descriptive statistics of 46 mining regions in transition (MRITs)

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Nord-du-Quebec, Canada	19 (84%)	7, 37% closing, (*7, 37% closed*)	0.926 V.H	55.1 M ↓ -10.6	**Low** L L-M L	0.0014 Low	93 Very high (RGI n/a)	0.05 Low	Gold (8 mines, 42%)	5% (#1)	OP #10 (53%) UG #7 (37%)	1
Valle de l'Or, Québec, Canada	11 (100%)	6, 55% closing, (*6, 45% closed*)	0.926 V.H	55.1 M ↓ -10.6	**Low** L L-M L-M	0.0211 Low	93 Very high (RGI n/a)	1.63 Low	Gold (10 mines, 91%)	9% (#1)	UG #9 (82%) OP #2 (18%)	1
Yukon, Canada	12 (58%)	7, 58% closing, *3, 25% closed*	0.926 V.H	55.1 M ↓ -10.6	**Low** L L-M H	0.0013 Low	93 Very high (RGI: n/a)	0.07 Low	Gold (8 mines 67%)	8% (#1)	Placer #6 (50%) OP # 4 (33%)	1
East Kootenay, British Columbia, Canada	6 (83%)	1, 17% closing, (*2, 33% closed*)	0.926 V H	55.1 M ↓ -10.6	**Low-Med** L L-M L	0.0469 Low	93 Very high (RGI n/a)	2.12 Low	Coal (5 mines 83%)	67% (#4)	OP #3 (83%) UG #1 (17%)	1
Fort Smith, Northwest Territories, Canada	11 (64%)	2, 18% closing, (*7, 64% closed*)	0.926 V. H	55.1 M ↓ -10.6	**Low** L L-M L	0.0006 Low	93 Very high (RGI n/a)	0.04 Low	Gold (6 mines 55%)	9% (#1)	OP #7 (64%) UG #2 (18%)	1

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Cochrane, Ontario, Canada	24 (100%)	10, 42% closing, *(7, 29% closed*)	0.926 V. H	55.1 M ↓ -10.6	**Low** L L-M L	0.0093 Low	93 Very high (RGI n/a)	0.56 Low	Gold (20 mines 83%)	8% (#2)	UG #15 (63%) OP #6 (25%)	1
Norrbotter county, Sweden	8 (75%)	1, 13% closing, (*2, 25% closed*)	0.933 V.H	48.4 M ↓ -10.4	**Low** L M-H M-H	0.0602 Low	95 Very high (RGI n/a)	2.21 Low <10/km^2	Iron ore (6 mines 75%)	50% (#4)	OP #6 (75%) UG #2 (25%)	1
Port Hedland, Western Australia, Australia	7 (100%)	2, 29% closing, (*5, 71%, closed*)	0.939 V. H	69.8 D ↓ -14.7	**Low-Med** L L L	0.0148 Low	92 Very high (RGI rank 8, satisfactory)	0.84 Low	Iron ore (5 mines 71%)	29% (#2)	OP #5 (71%) No data #2 (29%)	1
Charters Towers, Queensland, Australia	14 (71%)	2, 14% closing (*9, 64% closed*,)	O.939 V.H	69.8 D ↓ -14.7	**Low-Med** M-H L-M H	0.0122 Low	92 Very high (RGI n/a)	0.19 Low	Gold (11 mines 79%)	7% (#1)	OP #10 (71%) No data #3 (21%)	1
Cloncurry, Queensland, Australia	16 (100%)	4, 25% closing, (*4, 45% closed*)	0.939 V.H	69.8 D ↓ -14.7	**Low-Med** L-M L-M L	0.0076 Low	92 Very high (RGI n/a)	0.0748 Low	Copper (9 mines 56%)	6% (#1)	OP #13 (81%) UG #2 (13%)	1
Gunnedah, New South Wales, Australia	4 (100%)	1, 25% closing *3, 75% closed*	0.939 VH	69.8 D ↓ -14.7	**Med-High** L-M L L	0.3147 High	92 Very high (RGI: n/a)	2.69 Low	Coal (4 mines, 100%)	50% (#2)	OP #4 (100%) -	2

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Leonora, Western Australia, Australia	29 (100%)	10, 34% closing *8, 28%* *closed*	0.939 VH	69.8 D ↓ -14.7	**Med-High** H L L	0.0124 Low	92 Very high (RGI: rank 8, satisfactory	0.087 Low	Gold (24 mines, 83%)	3% (#1)	OP #25 (86%) UG #3 (10%)	2
Unincorporated South Australia, Australia	21 (57%)	8, 38% closing *6, 29%* *closed*	0.939 VH	69.8 D ↓ -14.7	**Med-High** H L-M L-M	0.0091 Low	92 Very high (RGI: n/a)	0.009 Low	Gold (6 mines, 29%)	24% (#5)	OP #13 (62%) U/G #3 (14%)	2
Laverton, Western Australia, Australia	12 (92%)	5, 42% closing *3, 25%* *closed*	0.939 VH	69.8 D ↓ -14.7	**Med-High** H L L	0.0039 Low	92 Very high (RGI: n/a)	0.008 Low	Gold (10 mines, 83)	25% (#3)	OP #12 (100%) -	2
Lake Macquarie, New South Wales, Australia	8 (100%)	1, 13% closing *4, 50%* *closed*	0.939 VH	69.8 D ↓ -14.7	**Med-High** L L L-M	0.5092 High	92 Very high (RGI: n/a)	300.72 Urban	Coal (8 mines, 100%)	50% (#4)	UG #8 (100%) -	2
Mid-Western, New South Wales, Australia	4 (100%)	1, 25% closing *1, 25%* *closed*	0.939 VH	69.8 D ↓ -14.7	**Low-Med** L L H	0.1109Mo der-ate	92 Very high (RGI: n/a)	2.86 Low	Coal (4 mines, 100%)	75% (#3)	OP #4 (100%) -	2
Waikato, New Zealand	12 (92%)	2, 17% closed *4, 33%* *closed*	0.917 VH	44.9 MD ↑ 0.1	**Low-Med** L M-H M-H	0.2492 Moderate	98 Very high (RGI: n/a)	16.43 Medium	Coal (8 mines, 67%)	8% (#1)	OP #7 (58%) No data #2 (17%)	2
Fairbanks Alaska, USA	5 (100%)	1, 20% closing, *2, 40%* *closed*	0.924 V H	41 M ↓ -10.8	**Low-Med** L M-H M-H	0.0415 Low	84 Very high (RGI n/a)	5.46 Low	Gold (5 mines 100%)	20% (#1)	OP #3 (60%) Placer #2 (40%)	1

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Mohave County Arizona, USA	12 (83%)	3, 25% closing, *5, 42% closed*	0.924 V.H	41 M ↓ -10.8	**Low-Med** M M-H M-H	0.0616 Low	84 Very high (RGI n/a)	6.49 Low	Silver (4 mines 33%)	8% (#1)	OP #5 (42%) No data #2 (17%)	1
St Louis Minnesota, USA	9 (100%)	2, 22% closing *3, 33% closed*	0.924 VH	41 M ↓ -10.8	**Low-Med** L-M M-H H	0.1169 Moderate	84 Very high (RGI: n/a)	11.20 Medium	Iron ore (9 mines, 100%)	56% (#5)	OP #7 (78%) No data #1 (11%)	2
Pershing Nevada, USA	8 (100%)	2, 25% closing *2, 25% closed*	0.924 VH	41, M ↓ -10.8	**Med-High** L M-H M-H	0.0171 Low	84 Very high (RGI: n/a)	0.42 Low	Gold (6 mines, 75%)	25% (#2)	OP #6 (75%) No data #1 (13%)	2
San Juan, New Mexico, USA	3 (100%)	1, 33% closing *1, 33% closed*	0.924 VH	41 M ↓ -10.8	**Med-High** H M-H H	0.1064 Moderate	84 Very high (RGI: n/a)	9.58 Low	Coal (3 mines, 100%)	33% (#1)	OP #2 (67%) UG #1 (33%)	2
White Pine, Nevada, USA	6 (100%)	3, 50% closing *3, 50% closed*	0.924 VH	41 M ↓ -10.8	**Med-High** M-H M-H M-H	0.0284 Low	84 Very high (RGI: n/a)	0.45 Low	Gold (4 mines, 67%)	33% (#2)	OP #5 (83%) UG #1 (17%)	2
HaDarom, Israel	4 (100%)	1, 25% closing *1, 25% closed*	0.903 VH	47.2 M ↓ -23.3	**High** L L-M H	0.3064 Moderate	70 High (RGI: n/a)	78.69 Medium	Copper (2 mines, 50%)	25% (#1)	OP #2 (50%) Brine #1 (25%)	2
Eastern Finland, Finland	7 (43%)	1, 14% closing	0.92 VH	57.2 M ↓	**Low-Med** L-M L-M	0.2164 Moderate	96 Very high (RGI: n/a)	9.369 Low	Nickel (3 mines, 43%)	14% (#1)	OP #2 (29%) No data #2	2

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km², medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
		4, 57% closed		-4.2	L-M						(29%)	
Nordrhein-Westfalen, Germany	15 (80%)	2, 13% closing *11, 73% closed*	0.936 VH	36.5 L ↓ -5.7	**Med-High** L-M L-M L-M	0.6799 High	89 Very high (RGI: n/a)	516.66 Urban	Coal (12 mines, 80%)	7% (#1)	UG #9 (60%) No data #3 (20%)	2
Andalucía, Spain	9 (78%)	2, 22% closing *4, 44% closed*	0.891 VH	39.2 L ↓ -9.5	**Med-High** L L-M L-M	0.3597 Moderate	75 Very high (RGI: n/a)	91.44 Medium	Copper (3 mines, 33%)	11% (#1)	OP #6 (67%) UG #2 (22%)	2
Orenburg, Russia	12 (75%)	2, 17% closing *3, 25% closed*	0.816 VH	77 D ↑ 6.8	**Med-High** H M-H H	0.3573 Moderate	29Low (RGI: n/a)	15.86 Medium	Copper (8 mines, 67%)	17% (#2)	OP #10 (83%) No data #2 (17%)	2
Navoi, Uzbekistan	10 (90%)	3, 30% closing *2, 20% closed*	0.71 H	89.1 D ↓ -0.7	**High** L M-H M-H	0.1656Mo der-ate	19 Very low (RGI: n/a)	12.12 Medium	Gold (6 mines, 60%)	10% (#1)	OP #7 (70%) Stockpile #1 (10%)	2
Beijing, China	12 (100%)	3, 25% closing *3, 25% closed*	0.752 H	53.1 M ↑ 3.5	**High** L L-M L-M	0.5957 High	43 Low (RGI: n/a)	1428.02 Urban	Iron ore (6 mines, 50%)	8% (#1)	UG #7 (58%) No data #4 (33%)	2
Coquimbo, Chile	20 (100%)	4, 20% closing *5, 25% closed*	0.843 VH	69.1 D ↓ -6.4	**High** M-H L-M M-H	0.1567 Moderate	80 Very high RGI: 5th Q	19.12 Medium	Copper (16 mines, 80%)	20% (#4)	OP #13 (65%) No data #4 (20%)	2
Itabira, Minas Gerais, Brazil	5 (100%)	3, 60% closing *1, 20% closed*	0.759 H	55.3 M ↓ -18.3	**Low-Med** L L-M H	0.3095 Moderate	42 Low RGI: rank 2, good)	115.76 Medium	Iron ore (4 mines, 80%)	20% (#1)	OP #5 (100%) -	2

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Paracatu, Minas Gerais, Brazil	3 (100%)	1, 33% closing *1, 33% closed*	H 0.759	55.3 M ↓ -18.3	**Low-Med** L L-M H	0.2091 Moderate	Low (RGI: n/a)	11.08 Medium	Gold (2 mines, 67%)	33% (#1)	OP #2 (67%) Placer #1 (33%)	2
Eduardo Neri, Guerrero, Mexico	3 (100%)	1, 33% closing *1, 33% closed*	H 0.774	53.2 M ↑ 0.2	**Low-Med** L L-M L-M	0.3518 Moderate	38 Low (RGI: rank19 satisfactory)	51.12 Medium	Gold (3 mines, 100%)	33% (#1)	OP #3 (100%) -	2
San Juan, Argentina	4 (75%)	3, 75% closing *1, 25% closed*	VH 0.825	58.4 M ↑ 0.5	**Med-High** L L L-M	0.0633 Low	52 Medium (RGI: n/a)	8.28 Low	Gold (4 mines, 100%)	25% (#1)	OP #3 (75%) No data #1 (25%)	2
La Libertad, Peru	15 (100%)	4, 27% closing *5, 33% closed*	0.75 H	80.1 D ↑ 9.8	**High** L L-M H	0.2805 Moderate	46 Medium (RGI: rank16 satisfactory)	72.99 Medium	Gold (13 mines, 87%)	13% (#2)	UG #7 (47%) OP #4 (27%)	2
Apurímac, Peru	4 (100%)	1, 25% closing *1, 25% closed*	0.75 H	80.1 D ↑ 9.8	**High** M L L-M	0.2658 Moderate	46 Medium (RGI: rank16 satisfactory)	19.42 Medium	Gold (2 mines, 50%)	25% (#1)	OP #2 (50%) No data #2 (50%)	2
Arequipa, Peru	17 (100%)	3, 18% closing *4, 24% closed*	0.75 H	80.1 D ↑ 9.8	**High** M L L-M	0.1336 Moderate	46 Medium (RGI: rank16 satisfactory)	21.27 Medium	Gold (12 mines, 71%)	6% (#1)	UG #8 (47%) No data #4 (24%)	2

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Cusco, Peru	4 (100%)	1, 25% closing *1, 25% closed*	0.75 H	VD ↑ 9.8	**Med-High** L-M M-H M-H	0.1887 Moderate	46 Medium (RGI: rank16 satisfactory)	17.59 Medium	Copper (3 mines, 75%)	50% (#2)	OP #2 (50%) No data #2 (50%)	2
Potosa, Bolivia	18 (78%)	5, 28% closing, *8, 44% closed*	0.693 M	84.5 D ↑ 13.8	**Med-High** H L-M H	0.1109 Moderate	29 Low (RGI: n/a)	7.37 Low	Zinc (10 mines, 56%)	17% (#3)	UG #11 (61%) No data #3 (17%)	3
Kankan, Guinea	7 (57%)	4, 57% closing *2, 29% closed*	0.459 L	94.3 D ↑ 22.1	**Low-Med** L-M L-M L	0.2366 Moderate	17 Very Low (RGI: rank 63, poor)	33.14 Medium	Gold (5 mines, 71%)	29% (#2)	OP #6 (86%) Placer #1 (14%)	3
Haut-Katanga, Democratic Republic of Congo	23 (87%)	7, 22% closing *5, 14% closed*	0.457 L	96.4 D ↑ 0.2	**Med-High** L L-M L-M	2.4309 Moderate	5 Very low (RGI: rank 75, poor)	48.09 Medium	Copper (17 mines, 74%)	4% (#1)	OP #14 (61%) No data #6 (26%)	3
Free State, South Africa	35 (89%)	12, 34% closing *7, 20% closed*	0.699 M	65.1 D ↓ -7.1	**Med-High** L M-H H	0.1875Mo der-ate	57 Medium (RGI: rank 23, weak)	21.07 Medium	Gold (21 mines, 50%)	17% (#6)	UG #23 (66%) OP #7 (20%)	3
Limpopo, South Africa	48 (92%)	7, 15% closing *10, 21% closed*	0.699 M	65.1 D ↓ -7.1	**Med-High** H H H	0.2458 Moderate	57 Medium (RGI: rank 23, weak)	43.83 Medium	Platinum (16 mines, 53%)	42% (#20)	UG #29 (59%) OP #8 (16%)	3

Location Region Country	**Intensity of mining** (# of mines and % clustered)	**Closure** (#, % mines closing <10 years) *(#, % closed)*	**Develop-ment** (HDI score+ VH-H-M-L)	**Dependency** (MCI value + D. MD, LD; Trend – direction + amount)	**Water risk** (**Overall** Regulation Quality Quantity)	**Natural environ-ment** (GHM Value + L-M-H)	**Governance** (WGI score + rating + RGI if available)	**Population density** (Value + low <10/km^2, medium (10.1 -150) and urban (>150)	**Prevailing commodity** (# and % mines in region)	**Large mines (R&R >100Mt)** (% number)	**Prevailing mine method** (OP; UG, number & %)	**Tier**
Gauteng, South Africa	49 (98%)	15, 31% closing *21, 43% closed*	0.699 M	65.1 D ↓ -7.1	**Med-High** L H M-H	0.5696 Moderate	57 Medium (RGI: rank 23, weak)	740.45 Urban	Gold (44 mines, 90%)	18% (#9)	OP #29 (60%) UG #15 (31%)	3
Northern Cape Province, South Africa	56 (96%)	8, 14% closing *12, 21% closed*	0.699 M	65.1 D ↓ -7.1	**Med-High** M-H H H	0.0431 Low	57 Medium (RGI: rank 23, weak)	3.26 Low	Diamonds (38 mines, 68%)	14% (#8)	Placer #24 (43%) OP #18 (32%)	3

4. Strengths of this method

This global scan mapped and explored mining regions and MRITs to demonstrate a method of assessing relative regional capacity to transition, The method was applied to 46 global mining regions that are presumed to be facing transition to post-mining futures. The research design recognises the interdependency of humans, social systems, institutional settings, natural systems, physical infrastructure and financial resources. It allows consideration of the local context in terms of the broader factors that influence capacity to create value, address risk and maintain sustainability in conjunction with mine closure. This report charts a conceptual sieving process for this analysis that tackles the following three major methodological challenges to date:

a. The meaningless profusion of data about mine closure resulting from many non-standardised case studies with little reliable evidence to recognise context-specific factors and support improved closure practice.

b. Lack of consistency, absence of agreed definitions, limitations on data availability and misinterpretation of available evidence that have hampered understanding of regional-scale dynamics and crucial factors in regional capacity to transition through mining lifecycle stages.

c. The absence of a globally coherent and consistent approach to assessing mine closure capacity that recognises mine closure as a regional issue rather than a mine-site, or company-specific one.

The method also considers the transition to closure as an extended process where mining practices that prevail in the region interact with socio-economic, environmental, governance and demographic characteristics of the regional context, to influence the capacity of the region to transition to closure. Contrary to suggestions that a region's post-mining future places responsibility for addressing discrete issues on either mining companies or government authorities, this method reveals the shared responsibilities and interaction of factors that is involved.

5. Data sources

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