GREENPEACE

Supplementary document to the report
"Beyond Extraction: Pathways for a 1.5°C-aligned Energy Transition with Less Minerals"

Development of a Restricted Areas Map for Transition Minerals Mining at a Global Scale

Greenpeace International, v1.0 March 2026

Summary

The global Restricted Areas Map for transition minerals mining has been defined by Greenpeace International to identify areas with high ecological, natural, and social values that should be off-limits to extractive activities such as transition minerals mining, in order to move the Earth's trajectory to one that limits global average temperature rise to no more than 1.5°C while also respecting other crucial interconnected planetary boundaries as well as the rights of Indigenous Peoples and Local Communities. Combined with Reserve Proxy Areas, the mapping also provides an indicative analysis of transition mineral reserves outside of areas that must be protected to respect planetary boundaries and aims to raise the public debate on risks of mineral demand projections in the context of the energy transition.

Based on criteria considering climate impacts, biodiversity, and nature, relevant spatial datasets have been identified which represent critical landscapes, protected areas, key biodiversity areas, ecosystems, carbon stocks, and water bodies. Valid global spatial datasets fulfilled some criteria: reliable sources (scientific), open data, the most up-to-date versions, the highest available spatial resolution and accuracy, and data format functionality (polygon, raster).

The available datasets were processed in Google Earth Engine to allow dynamic visualisation in order to analyse the datasets, performing, for instance, qualitative, comparative, and spatial representation checks. The initial variables were grouped into several normalised aggregated layers. Some of the datasets were considered a priori to be part of off-limits Restricted Areas in integral form (including, for example, Protected Areas, Intact Forest Landscapes, Mangroves, and the Global Ocean), whereas other datasets were reclassified to importance classes based on their values – Medium, High, and Very High.

Through an iterative process with the involvement of a group of experts, the methodology was optimised to produce a final version of the Global Restricted Areas Map. Four types of Restricted Areas were defined: Restricted Areas requiring the Free, Prior, and Informed Consent of Indigenous Peoples and Local Communities (RA-FPIC), areas that are off-limits to mining by default (RA1a), areas that are off-limits to mining by value (RA1b), and additional areas with high natural values (RA2).

Introduction

Defining Restricted Areas (RA) is a crucial step in ensuring that transition mineral exploration and extraction activities do not compromise areas of exceptional environmental and ecological importance, as well as Indigenous Peoples' and Local Communities' territories. We have now breached 7 out of 9 planetary boundaries that define the safe living space on Earth *(Stockholm University, 2023),* and Restricted Area elements are integral to at least four of these boundaries

(Climate Change, Biosphere Integrity, Land System Change, and Freshwater Change). RA are areas where extractive activities are considered incompatible with the need to safeguard biodiversity, ecosystem services, carbon storage, freshwater systems, and the rights of Indigenous Peoples and Local Communities (IP&LC). These zones are identified based on internationally recognised standards, scientific assessments, and ethical considerations, with the aim of protecting irreplaceable natural and cultural values. Establishing clear RA criteria helps align conservation goals with sustainable development and provides guidance for governments, industries, and stakeholders on where mining or similar activities should be strictly avoided.

Greenpeace International is defining a Restricted Areas map at a global level to estimate the reserves of transition minerals in relation to areas that should be off-limits to mining[1], and to inform governments, businesses, investors, certification systems, and the public on which areas of the Earth should not be mined. It targets decision-makers who are involved in the planning of mining activities to ensure that full consideration is given to biodiversity, nature, and the rights of Indigenous People and Local Communities.

The criteria for defining Restricted Areas are based on identifying areas with 'sensitive' values as per the previously published Greenpeace International report 'Minerals for Energy Transition: Greenpeace's Guiding Principles' (2025), including protected areas, areas with high conservation values, high carbon stock areas, significant natural ecosystems, critical water bodies, and Indigenous Peoples' lands where mining has been rejected. It means defining areas with biological, ecological, social, or cultural values which are considered significant or critically important at the national, regional, or global level.

The map is publicly available online at https://maps.greenpeace.org/maps/gpint/restricted-areas (Picture 1).

---

[1] Please see Chapter 6 of the report, *Beyond Extraction: Pathways for a 1.5°C-aligned Energy Transition with less Minerals*, and the supplementary document *"Minerals Mapping Approach and Integration with a Global Restricted Areas Map"* for detailed information on the minerals mapping methodology.

Picture 1. Global Restricted Areas Map for transition minerals mining

1.Resticted Areas criteria and Data

Building on the aforementioned guiding principles 'Minerals for Transition', the operational definition of Restricted Areas requires clear and measurable criteria. These criteria translate broad critical natural ecosystems and nature protection and rights-based values into specific spatial categories that can be consistently identified, mapped, and monitored at global and national levels. They serve as a practical foundation for distinguishing areas where mining activities are fundamentally incompatible with environmental and natural ecosystem protection, carbon storage, and the safeguarding of Indigenous Peoples' and Local Communities' rights. The criteria for defining the RA include the following key elements:

1. Protected Areas and Areas Recognised by International Conventions and Agreements (PA). These are all categories of protected lands and marine areas, including IUCN protected area categories I-VI, Indigenous Protected Areas (IPAs) and community conservation and protected areas (ICCAs), World Heritage Areas, Ramsar sites, Antarctica, UNESCO Global Geoparks and Biosphere Reserves.

2. High Conservation Value Areas (HCV). These are areas with biological, ecological, social or cultural significance, including Intact Forest Landscapes and Key Biodiversity Areas. They are identified as having one or more of the following six HCVs *(Areendran et al., 2020)*: species biodiversity, landscape-level ecosystems, habitats, ecosystem services, community needs, and cultural values. These areas need to be appropriately managed to maintain or enhance their intrinsic values.

3. High Carbon Stock Areas (HCS). This includes areas of vegetation or soils, particularly forests and peatland, that have high amounts of stored carbon, which, if cleared for mining, would create considerable emissions *(Mervine et al., 2025)*. These areas act as carbon sinks, absorbing carbon dioxide from the atmosphere and storing it in their biomass and soil. They are therefore significant for climate change mitigation. They are often also a proxy for high biodiversity. These areas include all tropical primary forests, mangroves, and high-biomass peatland soils, but also may include other forest areas and some wetlands or grasslands. Protecting HCS areas is crucial for climate change mitigation by maintaining their carbon storage capacity and preventing the release of stored carbon into the atmosphere.

4. Significant Natural Ecosystems (SNE). This includes ecologically important natural grasslands, wetlands, mangroves, small islands, coral reefs, shrublands, and savannah systems that may have high values. Many SNE will need to be evaluated for significance in local contexts.

5. Critical Water Bodies (CWB). The marine environment, including both shallow waters and the deep oceans (>200m depth), is categorised for protection due to their significant biodiversity and carbon values as well as the fundamental inability, based on the precautionary approach, to foresee and manage the environmental impacts of any mining of the seabed compared to on land, including the negative impact on marine biodiversity and fisheries and coastal fishing community customary rights. This CWB classification also includes all rivers, lakes, glaciers and other types of water bodies, significant streams or drinking water supply sources, as well as a buffer zone that is sufficient to ensure their protection.

6. Indigenous Peoples' and Local Communities' Territories (IP&LC). These include traditional and customary lands, territories, waters, coastal and communally owned areas, and the natural resources on which they depend, where IP&LC's Free, Prior, and Informed Consent (FPIC) is required, and additionally the territories of uncontacted or voluntary isolation peoples.

Based on the broad criteria mentioned above, global spatial datasets were chosen and analysed based on free availability, the most up-to-date sources, the highest spatial resolution and appropriate accuracy with minimum redundancy, and a well-described methodology. Relevant spatial data layers that have been selected and used in the process are listed in Table 1.

GREENPEACE

Table 1. Variables for Global Restricted Areas mapping

Variables	Source	RA Element
Protected Areas	*UNEP-WCMC and IUCN, 2025*	1.Protected areas
World Heritage Sites	*UNEP-WCMC and IUCN, 2025*	1.Protected areas
Ramsar Sites	*UNEP-WCMC and IUCN, 2025*	1.Protected areas
Antarctica	*GADM, 2025*	1.Protected areas
Key Biodiversity Areas	*BirdLife International, 2025*	2.High conservation value areas
Important Bird and Biodiversity Areas	*Waliczky et al., 2019*	2.High conservation value areas
Relative Species Richness	*UNEP-WCMC, 2025*	2.High conservation value areas
Plants Species Richness	*Sabatini et al., 2022*	2.High conservation value areas
Intact Forest Landscapes	*Potapov et al., 2008*	2.High conservation value areas
Forest Integrity Index	*Grantham et al., 2020*	2.High conservation value areas
Aboveground Live Woody Biomass	*Xu et al., 2021*	3.High carbon stock areas
Aboveground and Belowground Biomass Carbon Density	*Spawn et al., 2020*	3.High carbon stock areas
Peatlands Carbon Stock	*Widyastuti et al., 2025*	3.High carbon stock areas
Peatlands Thickness	*Widyastuti et al., 2025*	4.Significant natural ecosystems
Mangroves	*Mazur et al., 2025*	4.Significant natural ecosystems
Wetlands	*Zhang et al., 2023*	4.Significant natural ecosystems
Grasslands	*Parente et al., 2024*	4.Significant natural ecosystems
Small Islands	*Sayre, 2022*	4.Significant natural ecosystems
Steep Slopes	*Jarvis et al., 2008*	4.Significant natural ecosystems
Permanent and Natural Waters	*Potapov et al., 2022, Pekel et al., 2016*	5.Critical water bodies
Inland Waters Surface Density	*Lehner et al., 2024*	5.Critical water bodies
River Basins Physical Risks	*WWF, 2024*	5.Critical water bodies
Glaciers	*GLIMS Consortium, 2005*	5.Critical water bodies
Global Ocean	*Mikelsons et al., 2021*	5.Critical water bodies
Hongana-Manyawa uncontacted tribal territory	*Survival International, 2024*	6. IP&LC territories - uncontacted

1.1. Protected Areas and Areas Recognised by International Conventions and Agreements (PA)

Variables included that represent PA:
- Protected Areas, World Heritage Sites and Ramsar Sites – obtained from the World Database on Protected Areas and Other Effective Area-Based Conservation Measures dataset (UNEP-WCMC and IUCN, 2025). It represents the most comprehensive global spatial dataset encompassing both terrestrial and marine protected areas, which, by their meaning, have the highest conservation value. The dataset includes areas classified under all six International Union for Conservation of Nature (IUCN) protected area management categories, as well as areas for which no IUCN category was reported, assigned, defined or deemed applicable – such as *Terras Indígenas* in Brazil. Although more specialised or comprehensive datasets may exist for certain site types (e.g.,

Ramsar Sites or World Heritage Sites), the WDPA/WDOECM version was used to ensure consistency and comparability across all protected area designations. *Certain categories of protected and conserved areas were not fully represented in the version of the dataset used in this study, specifically, some Indigenous Protected Areas (IPAs), community-conserved areas (ICCAs), etc.*

- Antarctica – obtained from the global administrative areas database (GADM, 2025).

1.2. High Conservation Value Areas (HCV)

Variables included that represent HCV:

- Key Biodiversity Areas - obtained from a global map of Key Biodiversity Areas (BirdLife International, 2025) with more than 16,000 polygons worldwide safeguarding important populations of more than 13,100 species of conservation concern. They are sites that contribute significantly to the global persistence of biodiversity identified using internationally agreed scientific criteria. They represent places that are critical for the survival of species and ecosystems, ranging from habitats for threatened or geographically restricted species to areas that support large ecological processes. KBAs can be found across terrestrial, freshwater, and marine environments, and they often overlap with or complement existing protected areas. By highlighting the most important places for nature, KBAs provide a foundation for conservation planning, policy, and investment to ensure the long-term protection of biodiversity.
- Important Bird and Biodiversity Areas - obtained from an Important Bird and Biodiversity (BirdLife International, 2025) map with globally recognised sites that are critical for the conservation of bird populations and broader biodiversity. Identified through standardised criteria based on species' vulnerability, population size, and habitat significance, IBAs highlight key habitats for threatened, endemic, and migratory birds. While initially focused on avian conservation, IBAs are also valuable indicators of ecosystem health and often overlap with other priority sites for nature, such as protected areas and Key Biodiversity Areas. They serve as practical tools for guiding conservation action, policy development, and sustainable land and resource management.
- Relative Species Richness - obtained from the dataset (data dated 2022, 3 km/pix) that shows the relative abundance of species of amphibians, birds, mammals, reptiles, and a representative set of plant taxa. Derived from Areas of Habitat maps created from data from the IUCN Red List, BirdLife International, the Global Assessment of Reptile Distributions (GARD), the Botanical Information, and Ecology Network (BIEN) database. Additional vascular plant species ranges were created from point data from the IUCN Red List, Botanic Gardens Conservation International (BGCI), the Global Biodiversity Information Facility (GBIF), and iNaturalist. *Due to the low resolution of the source dataset, we additionally used the WWF Hydro Atlas (Linke et al., 2019) to assign each species richness value to its corresponding basin, ensuring better alignment with the other datasets used in this study.*

- <u>Plant Species Richness</u> - derived from a dataset (data dated 2013, 1 km/pix) that represents the global patterns of vascular plant alpha-diversity from 170,272 georeferenced vegetation plots worldwide, covering both forest and non-forest ecosystems at three spatial grains. The maps reveal spatial "scaling anomalies"—places where areas with high fine-scale richness differ from those with high coarse-scale richness—and help disentangle how environmental and sampling factors drive patterns of plant biodiversity. *Due to the low resolution of the source dataset, we additionally used the WWF Hydro Atlas (Linke et al., 2019) to assign each species richness value to its corresponding basin, ensuring better alignment with the other datasets used in this study.*
- <u>Intact Forest Landscapes</u> - obtained from a global dataset of Intact Forest Landscapes (data dated 2020, 30 m/pix) which represent a seamless mosaic of forest and naturally treeless ecosystems within the zone of current forest extent exhibiting no remotely detected signs of human economic activity or habitat fragmentation and are large enough to maintain all native biological diversity, including viable populations of wide-ranging species. IFLs are defined as a territory within today's global extent of forest cover which contains forest and non-forest ecosystems minimally influenced by human economic activity, with an area of at least 50,000 ha and a minimal width of 10 km (measured as the diameter of a circle that is entirely inscribed within the boundaries of the territory). They have high conservation value and are critical for stabilising terrestrial carbon storage, harbouring biodiversity, regulating hydrological regimes, for the livelihoods of Indigenous Peoples, and providing other ecosystem functions.
- <u>Forest Integrity Index</u> - obtained from a Forest Landscape Integrity Index dataset (data dated 2020, 30m/pix) that represents observed and inferred forest pressures and lost forest connectivity as determined by degree of anthropogenic modification.

1.3. High Carbon Stock Areas (HCS)

Variables included that represent HCS:
- <u>Aboveground Live Woody Biomass</u> - derived from a global map of Aboveground Live Woody Biomass Density (data dated 2021, 30m/pix), counted in megagrams of biomass per ha. Aboveground biomass was estimated using a multi-step process of calculating aboveground biomass at more than seven hundred thousand points with LiDAR with regional allometric equations, then using those to train a wall-to-wall model based on Landsat imagery.
- <u>Aboveground and Belowground Biomass Carbon Density</u> - derived from a Global Aboveground and Belowground Biomass Carbon Density map (data dated 2010, 30m/pix) that provides temporally consistent and harmonised global maps of aboveground and belowground biomass carbon density. The aboveground biomass map integrates land-cover-specific, remotely sensed maps of woody, grassland, cropland, and tundra biomass. Input maps were amassed from the published literature and, where

necessary, updated to cover the focal extent or time period. The belowground biomass map similarly integrates matching maps derived from each aboveground biomass map and land-cover-specific empirical models.

- Peatlands Carbon Stock - derived from PEATGRIDS/carbon dataset (data dated 2024, 1km/pix) containing peat thickness and carbon stock estimated over peatlands area across the globe. Carbon stock was calculated across all depths of the predicted peat thickness across five depths: 0-15 cm, 15-30 cm, 30-60 cm, 60-100 cm, and 100-200 cm.

1.4. Significant Natural Ecosystems (SNE)

Variables included that represent SNE:
- Peatlands Thickness - derived from PEATGRIDS/depth dataset (2024, 1km/pix) containing peat thickness and carbon stock estimated over peatlands area across the globe.
- Mangroves - extracted from the Natural Lands dataset (data dated 2024, 30m/pix) that represents the global extent of "natural" versus "non-natural" lands, covering the following land cover classes: forest, short vegetation, water, mangroves, bare, and snow/ice. The dataset is a compilation of the best available local and global land cover datasets. It synthesises multiple global and regional land cover/land use datasets (e.g., ESA WorldCover, UMD land cover, MapBiomas, cropland, and mining footprints) and overlays supplementary data to distinguish naturally functioning ecosystems from areas transformed by agriculture, built environments, plantations, or intensive management.
- Wetlands - derived from the global Wetland map (data dated 2022, 30m/pix) with a fine classification system using multi-sourced and time-series remote sensing imagery. It includes five inland wetland sub-categories (permanent water, swamp, marsh, flooded flat, and saline) and coastal tidal wetland sub-categories (mangrove, salt marsh, and tidal flats).
- Grasslands - extracted from Global Pasture Watch grassland (data dated 2022, 30 m/pix) in which the extent, dominant class, and probability are mapped annually for 2000-2022, including cultivated and natural/semi-natural grassland. *For this study only the natural/semi-natural grassland area for the year 2022 was used. Savanna and tundra areas are part of these grasslands. The results with a probability of more than 50% were taken for the analysis.*
- Small Islands - derived from the Landsat-based, Global Islands polygon data layer (data dated 2022, 30m/pix) produced from a semi-automated interpretation. *Only the islands less than 20,000 ha in size were taken into analysis for this study.*
- Steep Slopes - extracted from the Shuttle Radar Topography Mission (data dated 2000, 90m/pix) Digital Elevation Model. *Data for the entire world with slopes of more than 20 degrees were filtered from the dataset. These areas are highly sensitive to erosion and impact on water bodies.*

GREENPEACE

1.5. Critical Water Bodies (CWB)

Variables included that represent CWB:
- <u>Permanent and Natural Waters</u> - aggregated from water dynamics and water change datasets: Seasonal water and ice dynamics (data dated 2022, 30m/pix) and Atlas of global surface water dynamics (data dated 2020, 30m/pix). They represent the location and temporal distribution of water surfaces at the global scale over the past four decades and provide statistics on the extent and change of those water surfaces. *These two datasets were merged into one variable to extend the time range.*
- <u>Inland Waters Surface Density</u> - obtained from Global Lakes and Wetlands Database (data dated 2025, 500m/pix), a comprehensive and seamless global map of inland surface waters distinguished into 33 waterbody and wetland types.
- <u>River Basins Physical Risks</u> - obtained from the physical risk data from Water Risk Filter (data dated 2024) that represent both natural and human-induced conditions of river basins. It comprises four risk categories covering different aspects of physical risks: water availability, drought, flooding, water quality, and ecosystem services status. Therefore, physical risks account for conditions where water is too little, too much, unfit for use, and/or the surrounding ecosystems are degraded in turn negatively impacting water ecosystem services.
- <u>Glaciers</u> - derived from the Global Land Ice Measurements from Space (GLIMS) Glacier database (data dated 2005) provides comprehensive data on more than 200,000 glaciers worldwide.
- <u>Global Ocean</u> - extracted from a global land/water mask for satellite ocean colour studies in a medium resolution (data dated 2021, ~230 m). *Only an ocean mask was taken for this study.*

1.6. Indigenous Peoples' and Local Communities' (IP&LC) Territories

Apart from IP&LC lands that are considered protected or conservation areas[2], or the territories of uncontacted and voluntary isolation people (where data exists, such as the Hongana Manyawa in Indonesia), this element was excluded from global analysis due to the absence of consistent, complete, and relevant data about IP&LC territories across nations at a global scale.
- <u>Hongana-Manyawa uncontacted tribal territory</u> - derived from a distribution layer of one of the last nomadic hunter-gatherer peoples in Indonesia. Out of a total population of some 3,500 people, around 500 are uncontacted and refuse interactions with outsiders (Survival International, 2024).

In some countries where complete and verified IP&LC territory data sets exist, and after consultation with IP organisations, this is implemented at the national level as a specific '*Restricted Area requiring FPIC*' (RA-FPIC); for example, the Sámi lands in Sweden and Finland

---

[2] E.g. the demarcated territories of Indigenous Peoples in Brazil are included in the World Database on Protected Areas (UNEP, WCMC and IUCN 2025) data set of protected areas.

GREENPEACE

(*The Sámi Parliament*, 2016, *Act on the Sámi Parliament*, 2023). While there is emerging global and national data on IP&LC territories and waters *(e.g., Indigenous Region Registration Agency, 2025; Native Land Digital, 2025),* it is still incomplete, and thus it would be misleading to map only partial or incorrect data sets of IP&LC territories with a requirement for FPIC (it could be wrongly assumed that areas are not IP&LC territories if they are not mapped). As complete and verified IP&LC territorial data becomes available, it can be added. Therefore, for countries where the boundaries of IP&LC lands are not fully mapped, based on taking a precautionary approach, **all lands are assumed and considered as a '*Restricted Area requiring FPIC' (RA-FPIC)* or as *'Areas requiring free prior informed consent (FPIC) of Indigenous Peoples and Local Communities***.

2. Methods

To perform the analysis, we transformed the quantitative and qualitative metrics into comparable normalised raster layers with the same spatial resolution and projection. Normalisation includes reclassification to three classes - *Medium, High, and Very High* - reflecting the importance of each metric. We then aggregated normalised datasets in groups referred to Restricted Areas criteria picking maximum value for each cell. At the later stage, all aggregated layers were combined into a single, comprehensive layer. Each cell in this final layer was assigned one of three restriction types, corresponding to the three categories of restriction described in *Section 2.4: Restricted Areas Map*.

We used Google Earth Engine (GEE) as a platform for global dataset processing and analysis. GEE application with analytical tools was developed for testing and choosing the appropriate parameters. The overall scheme of analysis applied for land ecosystems is shown in Picture 2.
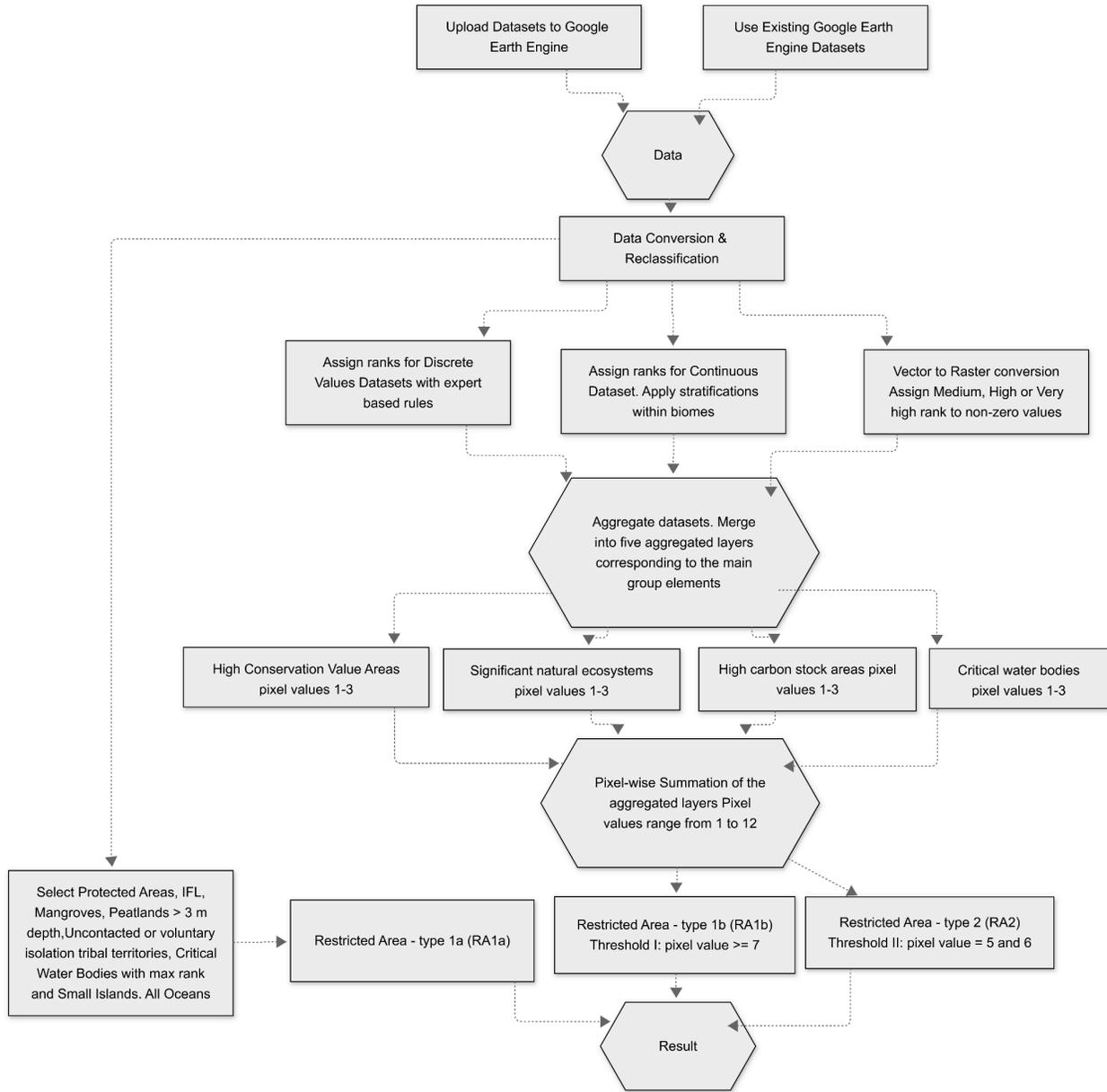
Picture 2. *Data analysis scheme*

2.1. Data preprocessing

To extract quantitative parameters from all spatial datasets, we converted them into the global raster layers in geographic coordinates (EPSG:3426 WGS84) with the same spatial resolution of 0.0025 degree/pixel (about 300 m on the equator). Vector reference maps were converted to the same raster format and reprojected. All further computations were performed using these raster datasets.

For some datasets, preprocessing included extraction of the proposed metric; for example, a steep slope layer was obtained using a threshold of value ≥ 21 degrees from a worldwide digital elevation model data, or we extracted particular classes of data, like mangroves from the Natural Lands dataset. Details of preprocessing for each layer are shown in Annex 1.

2.2. Reclassification of variables

To make consistent and comparable layers, we reclassified all data using the ranking *Medium / High / Very high* (*pixel value = 1, 2, or 3,* respectively). Details of reclassification and stratification for each variable are shown in Annex 1.

For *binary* datasets, a rank according to their importance based on experts' opinion was assigned to all nonzero values.

Discrete layers were manually reclassified based on expert opinion for class importance/class description and converted to ranked datasets.

For *continuous* datasets, all values were assigned to three ranked classes, with the values above the 95th percentile representing the maximum rank value (*Very high*). Values below the maximum rank threshold were equally split into two other classes: medium *and High.* This scaling minimises the impact of extreme values from the overall distribution on the thresholds selection.

For some continuous datasets, in addition to the analysis across the *Whole extent*, we applied an additional stratification based on natural biomes following *Mazur et al., 2025.* Specifically, within two biomes - *Forest* and *Short Vegetation -* the minimum and maximum ranks were estimated separately. All derived layers were then used as independent variables. In some cases, we also applied a *Natural Areas* mask based on the same dataset *(Mazur et al., 2025)*, which includes all *Forests, Short Vegetation, Water, Bare, and Snow* classes.

For example, the Aboveground Live Woody Biomass (LWB) dataset was classified into three categories in the whole dataset extent (Picture 3): *Medium (0 < LWB < 9 Mg/pix), High (9 ≤ LWB < 18 Mg/pix), and Very high (18 ≤ LWB ≤ 63).* The same LWB dataset was additionally reclassified separately for forests and short vegetation biomes. This additional step allows us to highlight not only pixels with maximum value of carbon stock but also maximum values of carbon stock in a particular biome. As shown in Picture 3, the differentiation between ecosystems becomes apparent: forest biomes display a much wider spread of biomass values, while short-vegetation biomes are concentrated at the lower end of the scale. These results demonstrate how reclassification through stratification not only makes datasets comparable but also preserves ecological relevance, allowing for consistent ranking across diverse environments.
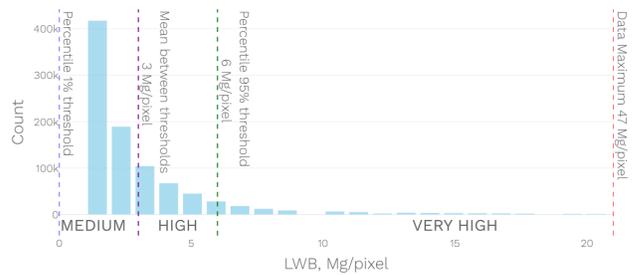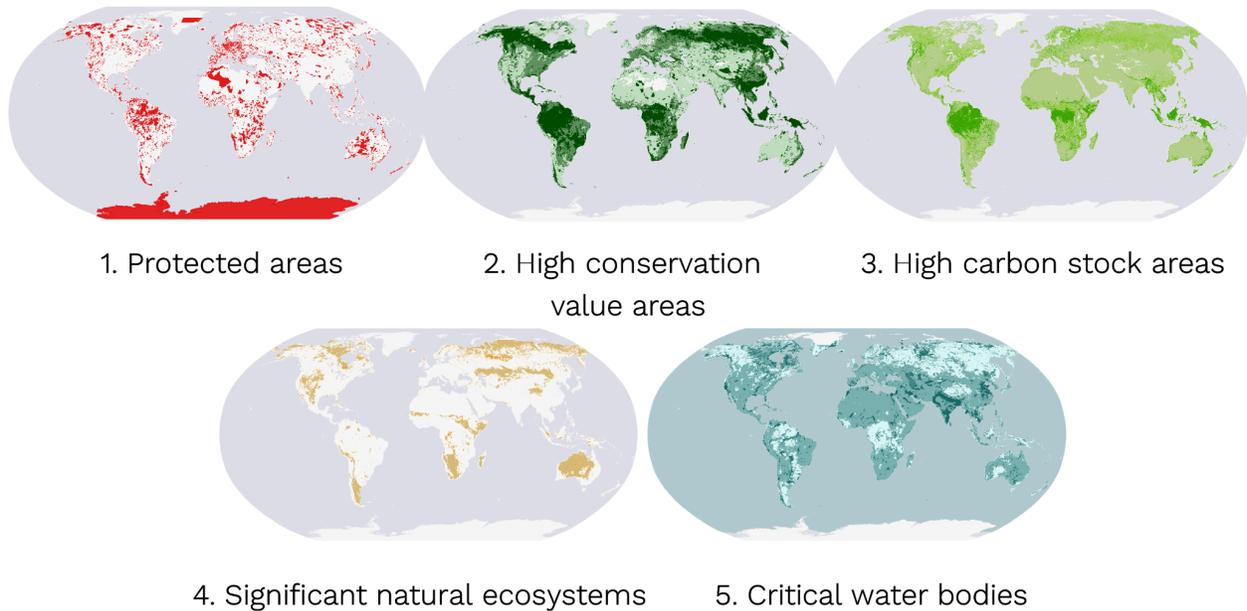
A.
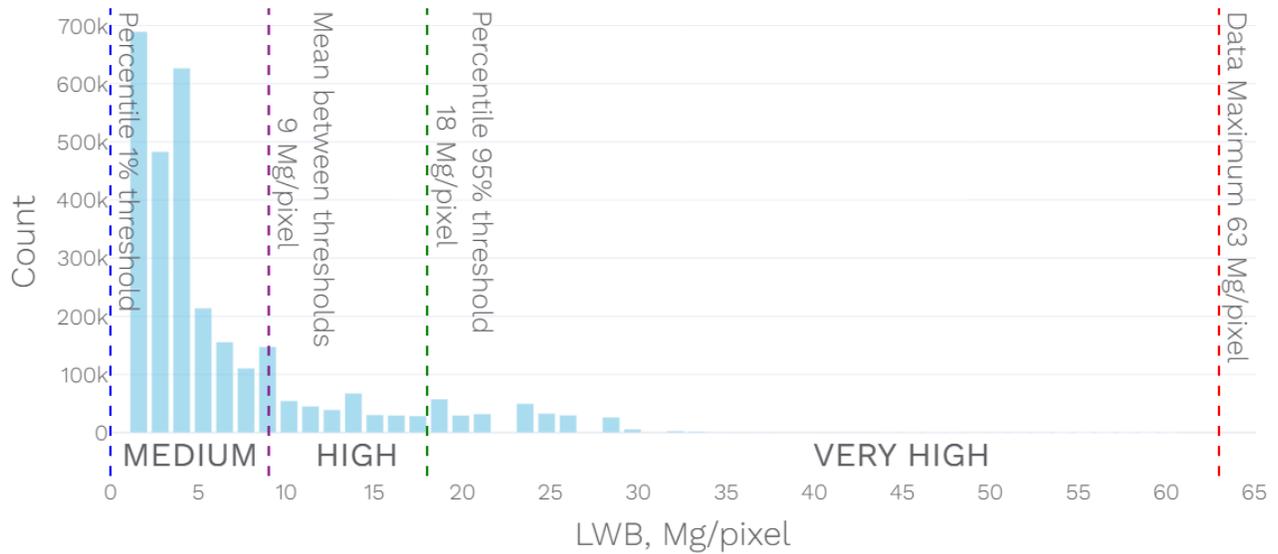
B.
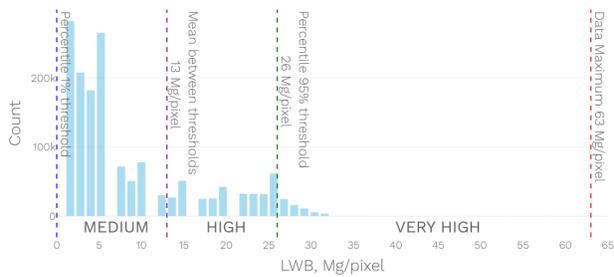
C.

Picture 3. *Aboveground Live Woody Biomass (LWB) distribution in Whole extent (A) and by biomes: Forest (B) and Short vegetation (C)*

2.3. Aggregated layers

Reclassified variables were merged into five aggregated layers corresponding to the main Restricted Areas (RA) elements (Table 1; e.g., High Carbon Stock Areas, High Conservation Value Areas). For each aggregated layer, pixels with the maximum rank value across all datasets in the respective group were selected. The resulting values in each aggregated layer were thus categorised into three classes: *Medium (pixel value = 1)*, *High (pixel value = 2)*, and *Very High (pixel value = 3)*. Aggregated layers are shown in Picture 4.

1. Protected areas   2. High conservation value areas   3. High carbon stock areas

4. Significant natural ecosystems   5. Critical water bodies

Picture 4. Aggregated layers according to each Restricted Area element and ranked with three classes. Global Ocean on Map 5 (Critical Water Bodies) is shown in a lighter colour for better visualisation

2.4. Restricted Areas map

There is an overarching Restricted Area requiring the Free, Prior, and Informed Consent of Indigenous Peoples and Local Communities (RA-FPIC) which covers all countries, but, due to lack of complete data sets, these territorial and water areas are not specifically mapped other than, for example, Sámi lands.

Then there are three types of Restricted Areas that are generated through combining all aggregated data layers, with each being defined according to slightly different criteria.

Firstly, we defined **Restricted Areas - type 1a (RA1a)**. These are all areas that, due to their critical importance, should be *off-limits to mining by default*. This includes all Protected Areas including IUCN protected area categories I-VI, Indigenous Protected Areas (IPAs) and community conservation and protected areas (ICCAs), World Heritage Areas, Ramsar sites, Antarctica, UNESCO Global Geoparks and Biosphere Reserves, Indigenous Peoples' lands that are legally protected from mining, territories of uncontacted or voluntary isolation tribes, Intact Forest Landscapes, areas of deep peat (>3m), mangroves, small islands, and most of the critical water bodies with a very high rank of importance, including the Global Ocean (see Annex 1). These areas were identified across all aggregated layers regardless of their cumulative

(summative) values and combined into a single final class (RA1a). There are no additional masks applied for these areas. They were then excluded from further classification in subsequent analysis.

After that we summarise the rest of the aggregated layers. Each aggregated layer containing pixel-wise rankings from 1 to 3 was first combined through pixel-wise summation to create a composite layer with values ranging from 1 to 12.

A threshold value of 7 was then selected to capture a pixel that has at least one layer with a very high value ranking (*pixel value = 3*) and one layer with a high value ranking (*pixel value = 2*), or three or more with high rankings (*pixel value = 2*). Applied to this composite raster, this produces a binary map (*pixel value ≥ 7*) which additionally was cropped with a natural lands mask *(Mazur et al., 2025)*. We defined them as **Restricted Area - type 1b (RA1b)**. These are areas that, due to their combination of **high natural values,** should also be *off-limits to mining by value*. In other words, these areas have a combined value of ≥ 7 according to the four aggregated layers/Restricted Areas criteria of High Conservation Value areas, High Carbon Stock areas, Significant Natural Ecosystems, and Critical Water Bodies.

The last, **Restricted Area - type 2 (RA2),** also based on values, is defined from the same layers but with a lower summative pixel value, in this case not less than 5 (*5 ≤ pixel value < 7*) which additionally was cropped with a natural lands mask *(Mazur et al., 2025)*. We consider these areas with combinations of very high, high or moderately high natural values as still important and *additional areas of high sensitivity or other areas with high natural values*, based on the presence of High Conservation Value areas, High Carbon Stock areas, Significant Natural Ecosystems and Critical Water Bodies.

As an important note and caution, these RA2 areas in particular require additional local site-specific higher-resolution data or assessments with input from local experts to both assess and identify clearly the values and then, through applying the precautionary approach, determine additional areas that should be off-limits and designated for protection.

The final Restricted Area map for transition minerals mining is presented in Picture 5.
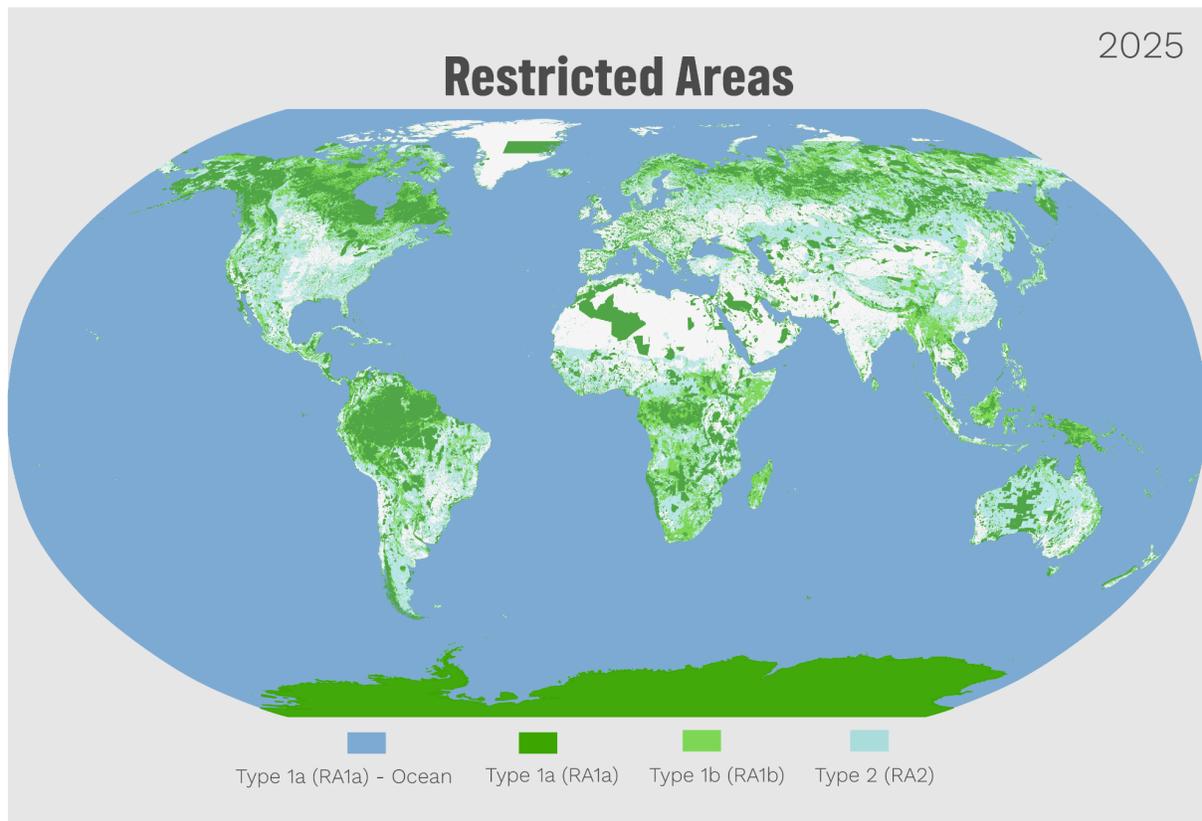
Picture 5. *Resulting Restricted Area map for transition minerals mining. Global Ocean is shown in a different colour for better visualisation*

3. Results and Discussion

Initial results of the analysis of the aggregated layers based on the 6 criteria using the Google Earth Engine platform were consulted on with allies, experts, and different Greenpeace offices. Input and feedback that was received was incorporated into the methodology and the presentation of the Restricted Areas. Key questions for the consultation included: what should the threshold be for the aggregated composite layer for the four values criteria, should this layer be considered 'No Go'/off limits or simply categorised as 'high risk' or 'high priority for protection', do the data sources capture all the key values, and should all marine areas be a 'No Go'/off limits zone. Following this, a validation process was carried out in two countries with very different contexts to check the global data against local data sets and local knowledge. Below, the general outcome of the global Restricted Area mapping is discussed, including its relevance and adjustment at a national level and the results of the validation process, as well as the strengths and limitations of the approach taken.

3.1. Global and national level of mapping

The Restricted Areas map represents a global-scale framework for identifying areas where transition mineral extraction poses unacceptable risks to climate stability, biodiversity and natural ecosystems, and people. This global map is based on internationally available datasets that meet the criteria of scientific reliability, openness, spatial resolution, and global consistency. It uniquely compiles these datasets for critical areas and values and acts as a common reference point for consideration of transition mineral mining at the planetary scale, ensuring that decisions align with the urgent need to stay within the 1.5°C climate limit, safeguard biodiversity and natural ecosystems, and respect Indigenous Peoples' and Local Communities' rights.

However, global-scale datasets have inherent limitations for decision-making at the national or local level. Their resolution and generalisation cannot fully capture local ecological conditions and environmental values or more recent data that might be available within individual countries. Additionally, there are very few complete data sets on IP&LC territories. Therefore, while the global Restricted Areas map provides a strong baseline, it is not intended to replace local assessment and local expert input and consultation for operational decision-making.

Local maps can be created by applying the same methodology to integrate higher-resolution or more up-to-date national datasets, such as detailed habitat maps, national protected area registers, Indigenous land boundaries, or local biodiversity surveys. Any additional datasets can be assigned to the relevant criteria (e.g., significant natural ecosystems or carbon storage) and classified into the 1-3 importance scale. Because the methodology aggregates normalised layers, there is no limitation on how many additional local datasets can be included – each will contribute proportionally to the final integrated layer.

In particular due to the spatial resolution of the global map being approximately 300m x 300m, the determination of the exact boundaries for the different RA areas of off-limits to mining by default (RA1a), off-limits to mining by value (RA1b), and other restricted areas with high natural values (RA2) can be verified and adjusted according to the national, regional, and local data, assessments, and experts' knowledge.

The result would be a local Restricted Areas map that mirrors the structure of the global one but with enhanced resolution and context-specific data that improves the local-level accuracy. Greenpeace offices, partner organisations, and local experts are encouraged to suggest and contribute additional datasets based on their expertise and knowledge of local landscapes. In this way, the global framework serves as a foundation, while local maps provide the necessary detail to support informed decision-making, advocacy, and policy at the country or regional level.

Comparison with national maps has been carried out for Indonesia (Picture 6) and Sweden (Picture 7) to validate the global data and determine if there is additional national-level data

needed. Overall, in both cases, the global data sets represented and aligned well with the situations at a national level, within the limitations highlighted above of data resolution, generalisation, and date. In Indonesia, small islands data was highlighted as an important data set, in part due to the national legal framework, and after consideration, small island data was subsequently added to the global data sets. In Sweden the Sámi territory was highlighted as a key data set, and as this was a complete and validated data set of Indigenous Peoples' territories, it was added as a specific national-level Restricted Area - RA-FPIC.

Restricted Areas
2025 INDONESIA

Type 1a (RA1a)   Type 1b (RA1b)   Type 2 (RA2)

Picture 6. Restricted Area map for transition minerals mining – focused on Indonesia. Global Ocean is not coloured for better visualisation

Restricted Areas   2025 SWEDEN
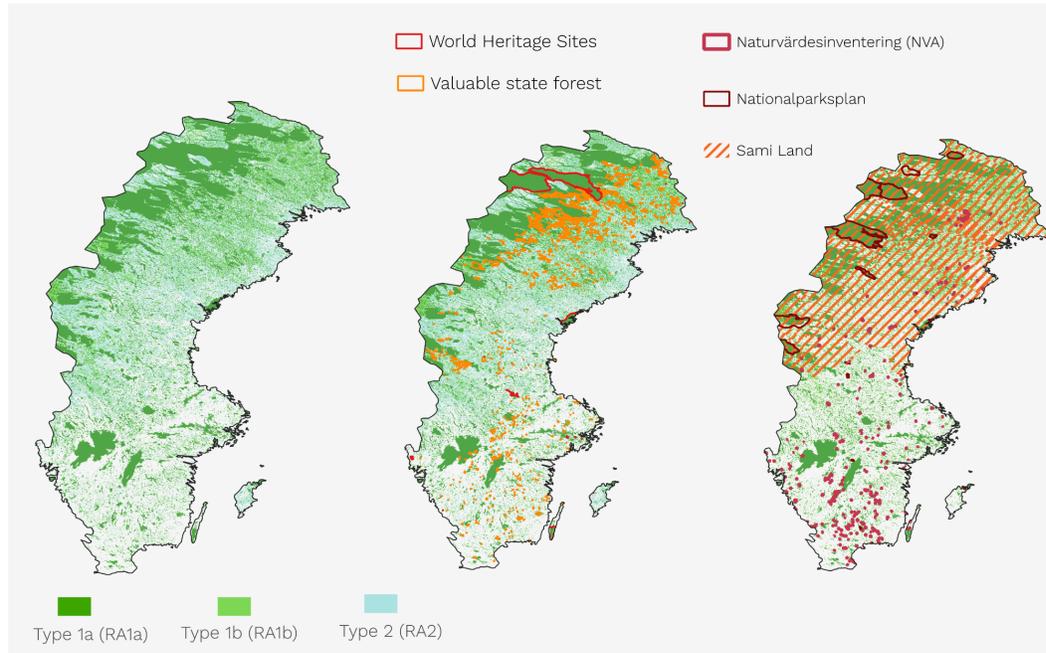
Picture 7. Restricted Area map for transition minerals mining – focused on Sweden. Global Ocean is not coloured for better visualisation

3.2. Strengths and Limitations of the approaches for Restricted Areas mapping

The Restricted Areas mapping approach provides a useful global framework and screening tool for identifying areas that, due to their critical environmental, ecological, natural, and/or social significance, should be considered restricted or off-limits for mining. By adding the case example of Potential Development Areas for selected transition minerals, the map also provides an indication of where mining may conflict with the protection of critical environmental, ecological, natural, or social areas and values that are essential to not breaching further key planetary boundaries.

This methodology should be seen as a unique approach that, for the first time, compiles and analyses established and credible data sets on Restricted Areas in relation to the threat of the rapid expansion of mineral mining. It should be viewed as indicative at a landscape level rather than definitive at an operational level and is a first version that is a methodological starting point that can be further tested, strengthened, adjusted, and expanded as needed. Moreover, this general method can be adapted to incorporate more detailed national, regional, and local data and maps.

GREENPEACE

It is important to note the following limitations to ensure appropriate interpretation and use of the map:

Data gaps and accuracy: The analysis relies on global datasets, which vary in detail, quality, and coverage – there are some gaps and inconsistencies in available data. In some parts of the world, data is missing, outdated, or too coarse to reflect local realities. This means that certain important areas – such as sites of ecosystem significance, localised biodiversity hotspots, or specific biodiversity habitats – may not be fully captured due to a lack of standardised, global-scale data. For example, remote sensing-derived land cover products often include misclassification errors, and slope models may be subject to topographic smoothing. The method excludes some data sets, such as on population, residential areas, local ordinances, agricultural lands, climate vulnerability data (e.g., floods and landslides), and conflict areas, with the exception of protected areas that may include urban/residential areas. Many of the datasets used do not cover Arctic and Antarctic regions.

Simplification challenges: To achieve comparability, input layers were normalised and reclassified using percentile-based ranking for continuous data and expert-informed binary categorisation for discrete data. While this simplification was necessary for data harmonisation, it introduces subjectivity and may reduce the richness of original classifications. For certain environmental data, we adjusted analysis by ecological zones (biomes) to avoid unfairly penalising some ecosystems, for example, forests. While this improves balance at the global scale, it cannot fully account for local environmental variation or the unique importance of specific landscapes. Although informed by expert knowledge, the chosen approach may not align with policy-relevant or ecologically critical thresholds.

It must be noted that:

- There is an overarching Restricted Area classification requiring the Free, Prior, and Informed Consent of Indigenous Peoples and Local Communities (RA-FPIC) which covers all countries, but, due to a lack of complete data sets, these territorial and water areas are not specifically mapped other than for example Norway, Sweden, and Finland Sámi lands.
- The Restricted Areas Map should be viewed as a global screening tool that provides indicative information on off-limits areas at landscape scale, not a final decision-making product. Site-specific and local data and assessments, expert input, and stakeholder consultation are essential before any land-use decisions are made.
- The map is based on the best available global data from a range of different credible sources. No Greenpeace data was collected or used for this map. The map's geographical base data, such as country areas, are linked under 'data sources' and are not endorsed by Greenpeace.
- And importantly, the Restricted Area map does not give a 'green light' or endorse mining activities outside of Restricted Areas. All areas outside of RAs may contain high values following local assessments and also require FPIC for any consideration of mining development.

References

Areendran, G., Sahana, M., Raj, K., Kumar, R., Sivadas, A., Kumar, A., Deb, S., Gupta, V.D., 2020. A systematic review on high conservation value assessment (HCVs): Challenges and framework for future research on conservation strategy. Science of The Total Environment 709, 135425. https://doi.org/10.1016/j.scitotenv.2019.135425

BirdLife International, 2025. *The World Database of Key Biodiversity Areas*. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. Available at https://www.keybiodiversityareas.org/sites/search

Druel, E., Ecologically or Biologically Significant Marine Areas (EBSAs): the identification process under the Convention on Biological Diversity (CBD) and possible ways forward. Working Paper N°17 /12 July 2012, IDDRI, Paris, France. https://www.iddri.org/sites/default/files/import/publications/wp1712_ed_ebsas.pdf. Available at https://www.cbd.int/ebsa

GLIMS Consortium, 2005. *GLIMS Glacier Database*. (NSIDC-0272, Version 1). [Data Set]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.7265/N5V98602. Available at https://www.glims.org/maps/glims

Grantham, H.S., Duncan, A., Evans, T.D., Jones, K.R., Beyer, H.L., Schuster, R., Walston, J., Ray, J.C., Robinson, J.G., Callow, M., Clements, T., Costa, H.M., DeGemmis, A., Elsen, P.R., Ervin, J., Franco, P., Goldman, E., Goetz, S., Hansen, A., Hofsvang, E., Jantz, P., Jupiter, S., Kang, A., Langhammer, P., Laurance, W.F., Lieberman, S., Linkie, M., Malhi, Y., Maxwell, S., Mendez, M., Mittermeier, R., Murray, N.J., Possingham, H., Radachowsky, J., Saatchi, S., Samper, C., Silverman, J., Shapiro, A., Strassburg, B., Stevens, T., Stokes, E., Taylor, R., Tear, T., Tizard, R., Venter, O., Visconti, P., Wang, S., Watson, J.E.M., 2020. Anthropogenic modification of forests means only 40% of remaining forests have high ecosystem integrity. Nat Commun 11, 5978. https://doi.org/10.1038/s41467-020-19493-3. Available at https://www.forestintegrity.com

Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008. Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT). Available at https://developers.google.com/earth-engine/datasets/catalog/CGIAR_SRTM90_V4

Lehner, B., Anand, M., Fluet-Chouinard, E., Tan, F., Aires, F., Allen, G.H., Bousquet, P., Canadell, J.G., Davidson, N., Finlayson, C.M., Gumbricht, T., Hilarides, L., Hugelius, G., Jackson, R.B., Korver, M.C., McIntyre, P.B., Nagy, S., Olefeldt, D., Pavelsky, T.M., Pekel, J.-F., Poulter, B., Prigent, C., Wang, J., Worthington, T.A., Yamazaki, D., Thieme, M., 2024. Mapping the world's inland surface waters: an update to the Global Lakes and Wetlands Database (GLWD v2). https://doi.org/10.5194/essd-2024-204. Available at https://www.hydrosheds.org/products/glwd

Linke, S., Lehner, B., Ouellet Dallaire, C., Ariwi, J., Grill, G., Anand, M., Beames, P., Burchard-Levine, V., Maxwell, S., Moidu, H., Tan, F., Thieme, M., 2019. Global hydro-environmental sub-basin and river reach characteristics at high spatial resolution. Sci Data 6, 283. https://doi.org/10.1038/s41597-019-0300-6.

Available at
https://developers.google.com/earth-engine/datasets/catalog/WWF_HydroATLAS_v1_Basins_level11

Mazur, E., Sims, M., Goldman, E., Schneider, M., 2025. SBTN Natural Lands Map – Technical Documentation.
https://sciencebasedtargetsnetwork.org/wp-content/uploads/2025/02/Technical-Guidance-2025-Step3-Land-v1_1-Natural-Lands-Map.pdf. Available at
https://developers.google.com/earth-engine/datasets/catalog/WRI_SBTN_naturalLands_v1

Mervine, E.M., Valenta, R.K., Paterson, J.S., Mudd, G.M., Werner, T.T., Nursamsi, I., Sonter, L.J., 2025. Biomass carbon emissions from nickel mining have significant implications for climate action. Nat Commun 16, 481. https://doi.org/10.1038/s41467-024-55703-y

Mikelsons, K., Wang, M., Wang, X.-L., Jiang, L., 2021. Global land mask for satellite ocean color remote sensing. Remote Sensing of Environment 257, 112356. https://doi.org/10.1016/j.rse.2021.112356. Available at https://data.mendeley.com/datasets/9r93m9s7cw/1

Minerals for Energy Transition: Guiding Principles, 2025. Greenpeace. Available at
https://www.greenpeace.org/static/planet4-international-stateless/2025/06/d9693389-minerals-for-transition_guide-principles.pdf

Parente, L., Sloat, L., Mesquita, V., Consoli, D., Stanimirova, R., Hengl, T., Bonannella, C., Teles, N., Wheeler, I., Hunter, M., Ehrmann, S., Ferreira, L., Mattos, A.P., Oliveira, B., Meyer, C., Şahin, M., Witjes, M., Fritz, S., Malek, Z., Stolle, F., 2024. Annual 30-m maps of global grassland class and extent (2000–2022) based on spatiotemporal Machine Learning. Sci Data 11, 1303. https://doi.org/10.1038/s41597-024-04139-6. Available at https://developers.google.com/earth-engine/datasets/publisher/global-pasture-watch

Pekel, J.-F., Cottam, A., Gorelick, N., Belward, A.S., 2016. High-resolution mapping of global surface water and its long-term changes. Nature 540, 418–422. https://doi.org/10.1038/nature20584. Available at https://developers.google.com/earth-engine/datasets/catalog/JRC_GSW1_4_GlobalSurfaceWater

Potapov, P., Hansen, M.C., Pickens, A., Hernandez-Serna, A., Tyukavina, A., Turubanova, S., Zalles, V., Li, X., Khan, A., Stolle, F., Harris, N., Song, X.-P., Baggett, A., Kommareddy, I., Kommareddy, A., 2022. The Global 2000-2020 Land Cover and Land Use Change Dataset Derived From the Landsat Archive: First Results. Front. Remote Sens. 3, 856903. https://doi.org/10.3389/frsen.2022.856903. Available at https://glad.umd.edu/dataset/GLCLUC2020

Potapov, P., Yaroshenko, A., Turubanova, S., Dubinin, M., Laestadius, L., Thies, C., Aksenov, D., Egorov, A., Yesipova, Y., Glushkov, I., Karpachevskiy, M., Kostikova, A., Manisha, A., Tsybikova, E., Zhuravleva, I., 2008. Mapping the World's Intact Forest Landscapes by Remote Sensing. Ecology and Society 13. https://www.ecologyandsociety.org/vol13/iss2/art51. Data available at https://intactforests.org/data.ifl.html

Sabatini, F.M., Jiménez-Alfaro, B., Jandt, U., Chytrý, M., Bruelheide, H., the sPlot Consortium, 2022. Global patterns of vascular plant alpha-diversity. https://doi.org/10.1038/s41467-022-32063-z. Available at https://idata.idiv.de/ddm/Data/ShowData/3506?version=70

Sayre, R., 2022. Global Islands - Public Domain Data [Data set]. GEO Knowledge Hub. Available at https://doi.org/10.60566/7yjze-2g558

Spawn, S.A., Sullivan, C.C., Lark, T.J., Gibbs, H.K., 2020. Harmonized global maps of above and belowground biomass carbon density in the year 2010. Sci Data 7, 112. https://doi.org/10.1038/s41597-020-0444-4. Available at
https://developers.google.com/earth-engine/datasets/catalog/NASA_ORNL_biomass_carbon_density_v1

Survival International 2024. Driven to the edge: How the demand for electric cars is destroying uncontacted Indigenous people's lives and lands in Indonesia. P24-28. https://www.survivalinternational.org/documents/DrivenToTheEdge

Waliczky, Z., Fishpool, L.D.C., Butchart, S.H.M., Thomas, D., Heath, M.F., Hazin, C., Donald, P.F., Kowalska, A., Dias, M.P., Allinson, T.S.M., 2019. Important Bird and Biodiversity Areas (IBAs): their impact on conservation policy, advocacy and action. Bird Conservation International 29, 199–215. https://doi.org/10.1017/S0959270918000175. Available at https://datazone.birdlife.org/search

Widyastuti, M.T., Minasny, B., Padarian, J., Maggi, F., Aitkenhead, M., Beucher, A., Connolly, J., Fiantis, D., Kidd, D., Ma, Y., Macfarlane, F., Robb, C., Rudiyanto, Setiawan, B.I., Taufik, M., 2025. Digital mapping of peat thickness and carbon stock of global peatlands. CATENA 258, 109243. https://doi.org/10.1016/j.catena.2025.109243. Available at https://zenodo.org/records/12559239

World Wide Fund for Nature, 2024. WWF Water Risk Filter Methodology Documentation. https://doi.org/10.5281/ZENODO.13768279. Available at https://riskfilter.org/water/explore/map

Xu, L., Saatchi, S.S., Yang, Y., Yu, Y., Pongratz, J., Bloom, A.A., Bowman, K., Worden, J., Liu, J., Yin, Y., Domke, G., McRoberts, R.E., Woodall, C., Nabuurs, G.-J., de-Miguel, S., Keller, M., Harris, N., Maxwell, S., Schimel, D., 2021. Changes in global terrestrial live biomass over the 21st century. Sci. Adv. 7, eabe9829. https://doi.org/10.1126/sciadv.abe9829. Available at https://data.globalforestwatch.org/datasets/gfw::aboveground-live-woody-biomass-density/about

UNEP-WCMC and IUCN, 2025. Protected Planet: [The World Database on Protected Areas (WDPA)/The World Database on Other Effective Area-based Conservation Measures (WD-OECM)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], 05/2025, Cambridge, UK: UNEP-WCMC and IUCN. Available at https://developers.google.com/earth-engine/datasets/catalog/WCMC_WDPA_current_polygons

UNEP-WCMC, 2025. Species richness. Derived from Areas of Habitat maps created from data from the IUCN Red List, BirdLife International, the Global Assessment of Reptile Distributions (GARD), the Botanical Information and Ecology Network (BIEN) database and additional vascular plant species ranges were created from point data from the IUCN Red List, Botanic Gardens Conservation International (BGCI), the Global Biodiversity Information Facility (GBIF) and iNaturalist. Cambridge, UK. Available at https://data-gis.unep-wcmc.org/server/rest/services/NatureMap/Species_richness/MapServer

Zhang, X., Liu, L., Zhao, T., Chen, X., Lin, S., Wang, J., Mi, J., Liu, W., 2023. GWL_FCS30: a global 30 m wetland map with a fine classification system using multi-sourced and time-series remote sensing imagery in 2020. Earth Syst. Sci. Data 15, 265–293. https://doi.org/10.5194/essd-15-265-2023. Available at https://zenodo.org/records/7340516

GREENPEACE

Annexes

ANNEX 1. Preprocessing and classification details for datasets

Data	Preprocessing and reclassification notes	Final Rank	Proposed Restricted Area
Protected Areas World Heritage Sites Ramsar Sites	● *Select from source appropriate protected area types* ● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1a
Antarctica	● *Select from source appropriate protected area types* ● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1a
Intact Forest Landscapes	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1a
Key Biodiversity Areas	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1b
Important Bird and Biodiversity Areas	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1b
Relative Species Richness	● *Due to low resolution of source dataset (~3km/pixel) we used WWF Hydro Atlas (Linke et al., 2019) to assign each value from source dataset to basin used* MEAN *as aggregation function at scale 300 m/pixel* ● *Result was converted to raster and reproject with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for whole data extent*	MEDIUM HIGH VERY HIGH	RA1b & RA2

GREENPEACE

Data	Preprocessing and reclassification notes	Final Rank	Proposed Restricted Area
Plants Species Richness	● *Due to low resolution of source dataset (~1km/pixel) we used WWF Hydro Atlas (Linke et al., 2019) to assign each value from source dataset to basin used* MEAN *as aggregation function at scale 300 m/pixel* ● *Result was converted to raster and reproject with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for whole data extent*	MEDIUM HIGH VERY HIGH	RA1b and RA2
Forest Integrity Index	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for a) whole extent, b) forests and c) short vegetation biomes strata*	MEDIUM HIGH VERY HIGH	RA1b and RA2
Above Ground Live Woody Biomass	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for a) whole extent, b) forests and c) short vegetation biomes strata*	MEDIUM HIGH VERY HIGH	RA1b and RA2
Aboveground and Belowground Biomass Carbon Density	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for a) whole extent, b) forests and c) short vegetation biomes strata*	MEDIUM HIGH VERY HIGH	RA1b and RA2
Peatlands Carbon Stock	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for whole extent*	MEDIUM HIGH VERY HIGH	RA1b and RA2

Data	Preprocessing and reclassification notes	Final Rank	Proposed Restricted Area
Peatlands Thickness	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for a) whole extent, b) forests and c) short vegetation biomes strata* ● *Select more than 3m depth for Type Ia*	MEDIUM HIGH VERY HIGH	RA1aa (> 3m) RA1b and RA2
Mangroves	● *Select from source all pixels with Mangrove class* ● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3* ● *Crop data with natural areas (Natural Lands layer)*	VERY HIGH	RA1a
Wetlands	● *Select from source wetlands classes and assign ranks:* *'swamp=3','marsh=3','flooded flat=1','saline=3','salt marsh=3','tidal flat=2'* ● *Reproject to raster with ground level resolution 300 m/pixel* ● *Crop data with natural areas (Natural Lands layer)*	MEDIUM HIGH VERY HIGH	RA1b and RA2
Grasslands	● *Select from source pixels with Probability>50* ● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign rank value =2* ● *Crop data with natural areas (Natural Lands layer)*	HIGH	RA1b and RA2
Small Islands	● *Select all islands less than 20,000 ha from the source data* ● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign rank value = 3*	VERY HIGH	RA1a
Steep Slopes	● *Select from source pixels with slope > 20 degree*	MEDIUM HIGH	RA1b and RA2

Data	Preprocessing and reclassification notes	Final Rank	Proposed Restricted Area
	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for whole extent*	VERY HIGH	
Permanent and Natural Waters	● *Reproject to rasters with ground level resolution 300 m/pixel* ● *Reclassify the first dataset to 3 rank classes using assign ranks:* `'Permanent Water=3','Water loss=3','Water gain=0','Lost seasonal=3','Stable seasonal=3','High frequency=3'` ● *Reclassify the second dataset to 3 rank classes using assign ranks:* `'Permanent=3','Lost permanent=3','New permanent=0','Lost permanent=3','Seasonal=3','Ephemeral=3'` ● *Merge two resulting layers* ● *Crop with natural areas (Natural Lands layer)*	VERY HIGH	RA1a
Inland Waters Surface Density	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify to 3 rank classes using 1-95 percentiles range for min/max for whole extent* ● *Class 3 was cropped with natural areas (Natural Lands layer)*	MEDIUM HIGH VERY HIGH	RA1a (very high), RA1b and RA2
River Basins Physical Risks	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Reclassify source risk map to 3 ranks classes using assign ranks:* `'1,2,3=1', '4,5,6=2', '7,8,9,10=3'`	MEDIUM HIGH VERY HIGH	RA1b and RA2

Data	Preprocessing and reclassification notes	Final Rank	Proposed Restricted Area
	● *Class 3 was cropped with natural areas (Natural Lands layer)*		
Glaciers	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1b
Global Ocean	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign minimum rank value = 3*	VERY HIGH	RA1a
Natural Lands	● *Twenty one source classes were reduced to five:* `1=Forests, 2=Short Vegetation, 3=Water, 4=Bare, 5=Snow` ● *Used in stratification for masks creation. Select class 1 to produce Forest mask, select class 2 to produce Short Vegetation mask, select classes 1-5 to produce Natural areas class* ● *Reproject to raster with ground level resolution 300 m/pixel*	-	
Hongana-Manyawa uncontacted tribal territory	● *Reproject to raster with ground level resolution 300 m/pixel* ● *Assign maximum rank value = 3*	VERY HIGH	RA1a