Author's Response to Reviewers' Comments

Manuscript: essd-2025-583

Global Surface Mining and Land Reclamation Time Series from 1985–2022

Dear Editor and Reviewers,

We sincerely thank the editor and reviewers for their careful evaluation of our manuscript and for their constructive suggestions. As requested by the editor and reviewers, we have revised the manuscript accordingly and provide below a consolidated point-by-point response to all comments. Our responses are shown in blue text, and the corresponding revisions are shown in red text. Line numbers refer to the revised manuscript.

Response to Report #1 - Anonymous referee #3

Comment 1:

Reviewer's Comment: *"I think that, within the current framework, the authors have conducted comprehensive evaluations and analyses. However, as I previously noted, and as also pointed out by other reviewers, the data used in this study are generated from existing classification products rather than from original remote sensing or other observational data. This inherently weakens the methodological novelty of the study to some extent and may also propagate uncertainties inherited from the underlying classification datasets."*

Response:

We thank the referee for this important clarification. We agree that our DEV and REC layers are not derived directly from original spectral-temporal breakpoint detection, but are inferred from land-cover transitions in an existing global classification product, GLC_FCS30D, within the refined mining boundaries. Therefore, uncertainties in the source land-cover product may propagate into our derived disturbance and reclamation layers.

To avoid overstatement of methodological novelty and to make the scope of the dataset clearer, we have revised the manuscript to explicitly state that the DEV and REC layers should be interpreted as GLC_FCS30D-based land-cover transition products rather than direct spectral-temporal breakpoint products. We also clarified why GLC_FCS30D was selected: among currently available global land-cover products, it uniquely combines global coverage, 30 m spatial resolution, annual temporal resolution after 2000, and an extended historical record back to 1985, which are required for long-term, fine-resolution, global mining-dynamic analysis.

In addition, we expanded the uncertainty and limitations section to more explicitly discuss the dependence of our workflow on the source LULC product. We emphasize that the dataset inherits classification uncertainties from GLC_FCS30D, particularly for gradual or fragmented reclamation processes and for environments where bare land and mining-related land covers are spectrally similar. We also refer to the cross-product sensitivity assessment with CLCD, which quantifies how inferred mining development and reclamation changes vary with the choice of source LULC product.

Overall, the revised text clarifies that the main contribution of this study is not the development of a fully independent mine-discovery algorithm from raw satellite observations, but the construction of a globally consistent, long-term mining-boundary and land-cover-transition dataset based on refined known mining footprints and harmonized land-cover time series.

Manuscript revision: Lines 250-253, Section 2.2.

Revised text:

The resulting DEV and REC layers should therefore be interpreted as GLC_FCS30D-based land-cover transition products rather than direct spectral-temporal breakpoint products. Because the workflow uses an existing global land-cover classification product as input, errors and uncertainties in the source LULC classes may propagate into the derived disturbance and reclamation layers. GLC_FCS30D was selected because, among currently available land-cover products, it uniquely combines global coverage, 30 m spatial resolution, annual temporal resolution after 2000, and an extended historical record back to 1985, which constitutes the combination of properties required for long-term, fine-resolution, global mining-dynamic analysis.

Comment 2:

Reviewer's Comment: *"In addition, as I mentioned in my previous review, the proposed approach is unable to recover mining areas that are absent from the original datasets. From an evaluation perspective, this implies that the present study mainly improves classification precision, but does not directly enhance the completeness (recall) of the results. This issue may limit the broader usability of the dataset."*

Response:

We thank the referee for raising this important point. We agree that our approach cannot recover mining areas that are absent from the original input inventories. Our workflow is designed to refine and track known mining footprints rather than to perform unconstrained global mine-site discovery. As a result, the dataset primarily improves the geometric precision and spatial consistency of already identified mining regions, while it does not directly improve the recall or completeness of global mining-site detection.

We have revised the manuscript to state this limitation more explicitly. In the uncertainty and limitations section, we now clarify that our refined boundary dataset is conditional on the completeness of the two input mining inventories. Newly developed mines after the approximate source delineation period, small or informal/artisanal mines below the detection thresholds of the source datasets, and regions where both input inventories share systematic omissions may be under-represented or absent from our dataset.

We also clarified the intended use of the dataset. The dataset is most suitable for analyzing land-cover transitions, disturbance, and reclamation dynamics within known or previously mapped mining regions. It should not be interpreted as a complete global inventory of all mining sites. Future work that integrates time-series mine-discovery algorithms or high-resolution machine-learning mapping could help address this limitation and improve global recall.

Manuscript revision: Lines 921-927, Section 4.3.

Revised text:

This design improves boundary precision and reduces overestimated non-mining areas within known mining footprints, but it cannot discover mining sites absent from both source datasets. The "maximum potential mining disturbance boundary" used in this study should therefore be understood as a refined boundary conditional on the completeness of the input inventories. Newly developed mines after the circa-2020 source delineation date, small or informal/artisanal mining sites below the spatial-detection threshold of either source, and regions where both inventories share systematic omissions (e.g., certain artisanal-mining belts) may be under-represented or missing from the refined dataset. Consequently, our dataset primarily enhances the geometric precision of already identified mining regions and improves spatial consistency. It does not directly increase the completeness, or recall, of global mining-site detection; users applying the dataset for global mining-area accounting should account for this scope. Future work integrating time-series mining-site discovery methods could address this limitation and provide a more complete picture of mining's evolving spatial footprint.

Comment 3

Reviewer's Comment: *"I would also recommend improving the color design of several figures to enhance readability. For example, the yellow color used in Figure 6a is not sufficiently distinguishable, which may make it difficult for readers to accurately identify the corresponding regions. A similar issue is present in Figure 8b."*

Response:

We thank the referee for this helpful suggestion. We agree that improving the color design of the figures can enhance readability and help readers more clearly identify the corresponding regions and categories. Accordingly, we revised the color schemes and symbol design of the relevant figures.

For Figure 6a, we revised the color ramp used for mining area density within KBAs. In the original version, the lowest-density class was shown in bright yellow, which was not sufficiently distinguishable against the light map background. We therefore replaced the original yellow-to-red ramp with a more distinguishable blue-orange-red gradient and adjusted the continental background to a light gray tone. These changes improve the contrast among low-, medium-, and high-density regions and make the spatial pattern easier to interpret.

For Figure A3, we made a consistent revision to the global mining density map by replacing the original yellow-to-red ramp with the same improved blue-orange-red gradient. This ensures visual consistency with Figure 6a and improves the readability of mining-density variations across regions.

For Figure 8b, we revised both the color design and the symbol design for the three mining-area status categories. In the original version, the stable category was shown in orange, which was not sufficiently distinguishable at the global scale. In the revised version, Closed Mines are shown in green (#1B9E77), Stable Mines in gray (#9E9E9E), and Active Mines in dark red (#B2182B). In addition, instead of rendering the mining areas as Earth Engine painted raster pixels, we now represent each mining area by its centroid marker. We further used different marker shapes to distinguish the three categories: circles for Closed Mines, squares for Stable Mines, and triangles for Active Mines. This combined use of color and marker shape improves readability, especially in regions where points are dense or overlapping.

We also corrected several minor caption issues. In the captions of Figure 6a and Figure A3, “100 x 100 km” was revised to “100 × 100 km” for typographic consistency. The caption of Figure 8 was also refined to more accurately describe the revised centroid-marker representation and the meaning of the three mining-area status categories.

Manuscript revision: Figure 6, Lines 526-535

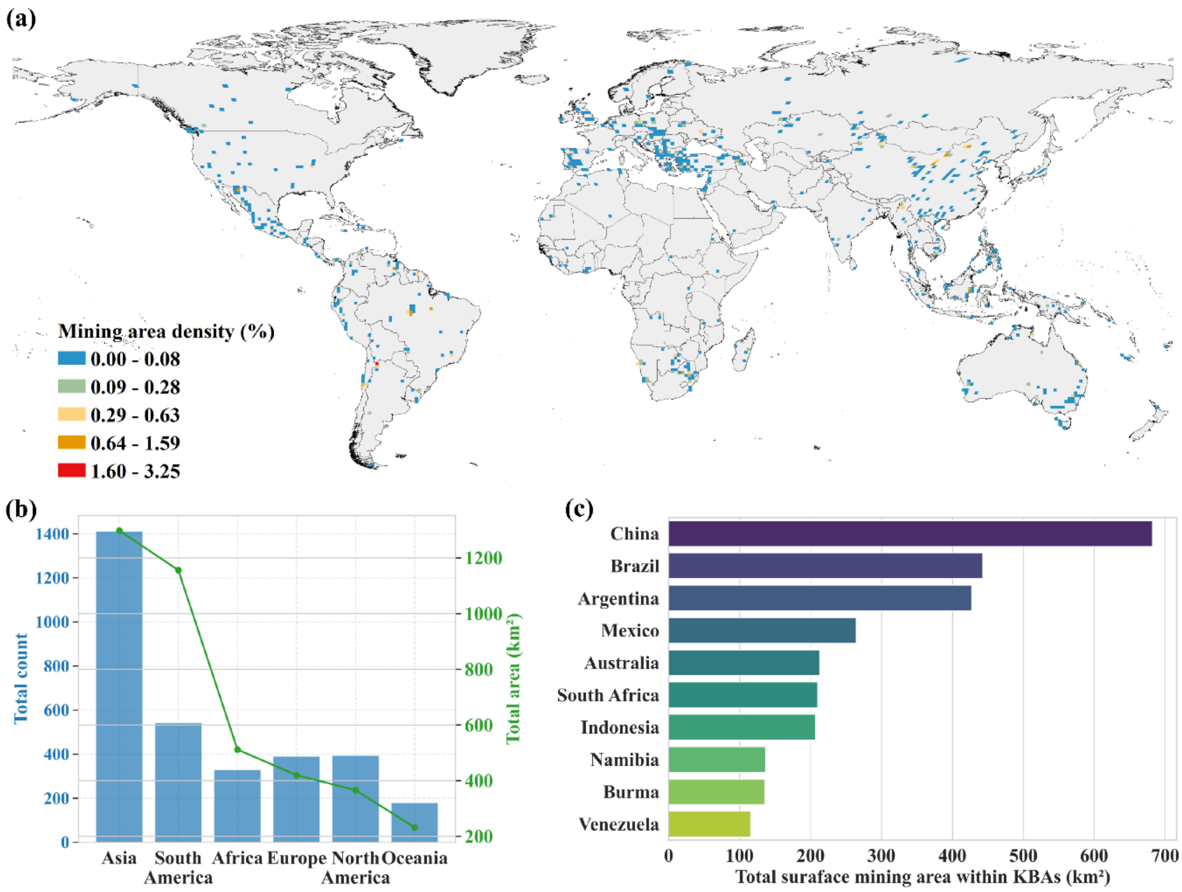

Figure. 6 Global distribution and characteristics of mining polygons within KBAs. (a) Global mining density within KBAs in a 100 km grid. Mining area density is calculated as the proportion of mining area within 100 × 100 km (10,000 km2) grid cells. Data was aggregated using the Interrupted Goode Homolosine equal-area projection to ensure accurate area calculations. The map is displayed using the PlateCarree projection. The boundary and attribute data of KBAs used in this study are obtained from the World Database of Key Biodiversity Areas (https://www.keybiodiversityareas.org/). (b) Counts and total area of mine within KBAs by world regions. (c) Top 10 countries by mining area within KBAs.

Manuscript revision: Figure A3, Lines 1070-1074

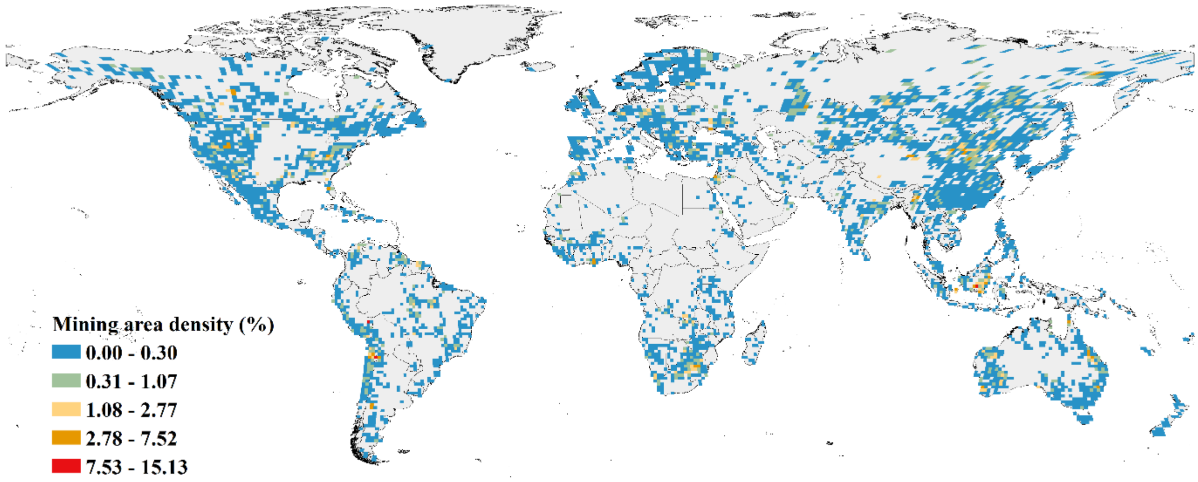

Figure. A3 Global mining density in a 100 km grid. Mining area density is calculated as the proportion of mining area within 100 × 100 km (10,000 km2) grid cells. Data was aggregated using the Interrupted Goode Homolosine equal-area projection to ensure accurate area calculations. The map is displayed using the PlateCarree projection.

Manuscript revision: Figure 8, Lines 692-703

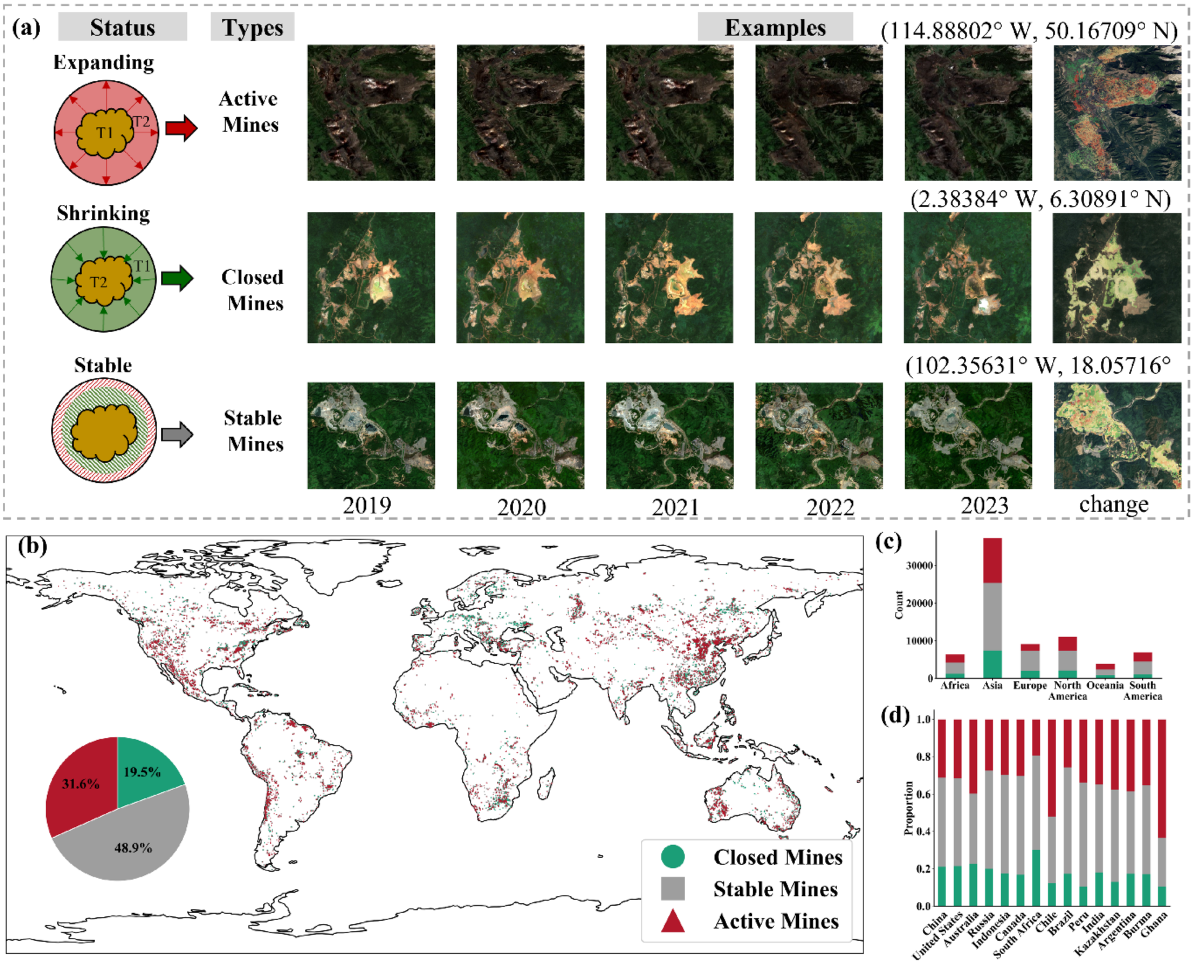

Figure. 8 (a) Classification of development status of mining areas in the recent five years: active, stable, closed. For the change maps corresponding to each development status category, two distinct change directions are denoted by specific colors: Red pixels indicate a land cover transition from non-mining-related types to mining-related types, representing the expansion of mining areas. Green pixels indicate the inverse transition—from mining-related land cover types to non-mining-related types—representing the shrinkage of mining areas. (b) Global distribution of three types of mining areas. Each mining area is represented by its centroid marker. Closed, stable, and active mining areas are shown using different colors and marker shapes. (c) Continental counts of mining areas types (d) Type structures of the top 15 countries, sorted by the total number of mining areas in descending order.

Response to Report #2 - Anonymous referee #1

We thank Referee #1 for the careful evaluation and for recommending the manuscript for acceptance. As no specific revisions were requested, no changes were made in response to this report. The revisions described above (in response to Referee #3) have been incorporated and do not alter the scientific conclusions of the study.

We thank the Editor and both Referees again for their constructive comments, which have helped improve the clarity and readability of the manuscript. We hope that the revised version is now suitable for publication.

Sincerely,
The Authors