Dear Anonymous Referee #1,
Thank you for your valuable feedback and discussion points. We appreciate the time and effort you invested in reviewing our manuscript. In the following, we address each of your comments in detail.

Comment: A result map from each data source is required. Provide spatial evidence to support the claim regarding the detailed delineation of patches across the three data sources.

Answer:

We appreciate this suggestion. However, including a result map for every data source would require at least three additional figures, each representing only a single year, date or time period, depending on the respective dataset. To balance completeness and conciseness, we added a figure of comparison for the SED and PS Results (Fig. 7) in section 4.4.

Comment: The text lacks quantitative depth. When discussing increases in mining area, provide specific numerical values (e.g., km2 or % increase).

Answer:

We agree that this information would improve the clarity of the manuscript and will incorporate it accordingly in the revised version (see section 4.1 and 4.2).

Comment: In the Discussion, the authors link temporal trends to gold prices. This should be supported by adding a time-series graph of monthly or annual gold prices, perhaps overlaid on Figures 4 and 5.

Answer:

This is a valid point and a direct comparison between the results and gold price developments would strengthen the discussion. Therefore, we will include an improved figure in the revised manuscript that overlays the observed results with gold price trends to better illustrate potential relationships and support the interpretation of the findings (see Fig. 4).

Comment: Moving Section 5.1 (Validation) into the Results section would significantly strengthen the paper. Beyond descriptive comparisons, also include figures or tables supporting these comparisons. Even a few representative examples would provide strong visual evidence. Furthermore, Fig. 7 could be complemented with the percentage of area detected relative to the validation datasets.

Answer:

We agree that moving this section would improve the overall structure and readability of the manuscript and we will revise the organization accordingly. In addition, we believe that including a figure comparing the results from the different approaches for one

representative Sub-AOI and a comparable time step would be valuable. Such a figure would provide a direct comparison of the datasets and would also demonstrate consistency in the spatial distribution of detected mining sites across the different approaches, thereby also showing the validity of the results. This addition would also address the first comment regarding the inclusion of result maps (see section 4.4 and Fig. 7).

A direct comparison of the percentages shown in Figure 7 is of limited value because the underlying methodologies differ substantially. We will therefore add a reference to the Amazon Mining Watch (AMW) methodology and further clarify these differences in the manuscript. Specifically, the AMW dataset identifies mining activity using relatively coarse polygons that indicate areas where mining has been detected, whereas the approach presented in this study provides a more detailed and spatially precise delineation of mining sites. To avoid potential misinterpretations, we will revise the text to clearly explain these methodological differences and discuss their implications for the interpretation and comparison of the results (see section 4.4).

Comment: Results are currently presented by AOI names. I suggest adding the corresponding identification numbers from Figure 1 to make it easier for the reader to cross-reference locations.

Answer:

Yes, that will be done.

Comment: Figure 4 shows a reduction in the bars representing km2 and percentages for certain periods. Is this a technical artifact of the dataset/methodology, or does it represent a physical contraction in mining activity? Please provide an explanation in the text.

Answer:

The results show a decrease in mining sites for specific AOI's and timeframes, a further explanation will be given in the text (see section 4.1).

Comment: The abstract requires numerical results to summarize the findings effectively. For example: Results show a pronounced increase in mining extent (xxx km2) and associated deforestation across all study areas, with particularly strong expansion during 2023 and 2024 (from xx to xx or % of increase).

Answer:

Numerical results will be added to the abstract.

Comment: The term "policy shifts" is vague. Please specify the nature of these shifts.

Answer:

We agree that the current terminology could be improved. In the revised manuscript, we will replace this term with a more appropriate description of the political, regulatory, and security-related developments affecting the Ecuadorian mining sector. We will also expand the accompanying discussion to provide additional context and improve the clarity of this aspect of the analysis.

Comment: Add a map showing legal concessions in the region.

Answer: Yes, that will be added (see Fig. 1, Fig. 7).

Comment: The study area map should locate Ecuador within South America. Explicitly mention that the study regions belong to the Amazon River basin.
Answer:

This will be incorporated into the revised manuscript (see Fig. 1 and section 2).

Comment: Ecuador has four geographical regions: Coast, Andes, Amazon and Insular (Galápagos).
Answer:

The text will be changed accordingly (see section 2).

Comment: Add the description of the two validation datasets in the "Data and Methods" section.
Answer:

Descriptions will be added (see section 3.3).

Comment: Paragraph 120, specify the exact number of training samples used and the years they cover. This is a critical step in the methodology.

Answer:

For the SED dataset in total 10 training samples were used, this information will be added to the text (see line 159).

Comment: Clarify the criteria for "scene complexity" mentioned in paragraph 155. Did the authors test training using only a single year of data?

Answer:

We will clarify this point in the manuscript by explicitly defining scene complexity as the diversity of landforms present within a scene. We will also note that the dataset exhibited interannual variability, with some areas appearing differently across years, as well as occasional spectral artefacts in the data. Furthermore, we will state that training data from three reference years were used to account for these variations and improve model robustness (see section 3.1.1).

Comment: In paragraph 305, the term "AI-generated embeddings" appears without prior context. Please introduce or define this term earlier.

Answer:

We will clarify in the revised manuscript that the AI embeddings are based on the same contextual information used for the Google Satellite embedding dataset.

Comment: In paragraph 85, specify the reference year for the AOIs and clarify why certain areas were discharged while others were selected, and under which criteria.

Answer:

Paragraph 85 does not explicitly refer to reference years; however, we understand that the concern relates to the selection of reference years and scenes for the PlanetScope dataset. In the revised manuscript, we will further clarify the rationale for selecting three different reference years. In addition, we will link this choice to the concept of scene complexity, thereby providing a more comprehensive explanation of the training data compilation process (see section 3.1.2).

Comment: The discussion assumes detected deforestation is exclusively from mining. Please address potential "false positives," such as agriculture, cattle ranching, or logging as alternative (possible) drivers.

Answer: While we assume that the detected deforestation is primarily associated with mining activities, this assumption is based on the pre-selection of AOIs using reports and external sources documenting unregulated mining, as well as the consistent presence of characteristic mining-related features such as water-filled pits across all scenes. However, we agree that it cannot be stated with certainty that all detected deforestation is exclusively attributable to mining. We will therefore revise the manuscript to explicitly address this limitation and discuss the potential for additional contributing drivers in the interpretation of the results (see section 5.1).

Comment: Compare the findings with similar remote sensing applications in other regions. Did you find similar conclusions or experiences compared to other related works? What knowledge developed for Amazon might be useful in other contexts/regions?

Answer:

Thank you for this suggestion. We agree that placing our findings within related remote sensing applications strengthens the discussion and highlights the broader relevance of the study. We will therefore expand the manuscript to compare our results with previous studies on remote sensing-based mining monitoring in other regions. Our findings reflect the growing importance of remote sensing for monitoring unregulated mining activities, which have increased globally over the past decade. While this study focuses on the Ecuadorian Amazon, similar challenges have been reported in other parts of

South America, Sub-Saharan Africa, and Asia, where mining often occurs in remote areas. However, other assessments also identify Ecuador as a high-risk country for illegal mining (e.g. https://www.miningmagazine.com/community/research-articles/4525916/revealed-worlds-illegal-mining-hotspots), underscoring the need for scalable monitoring approaches. In our study, the Amazon Mining Watch (AMW) dataset provided a benchmark for validation and comparison. Such reference datasets are however, often unavailable in other affected regions, and field-based validation is often not feasible due to accessibility and safety constraints. Consequently, the development of robust validation strategies remains a major challenge for transferring remote sensing-based mining monitoring frameworks across regions.

Finally, we would like to emphasize that, while previous studies have typically relied on individual datasets or specific approaches, our study is among the first to systematically integrate and compare multiple complementary data sources across different spatial and temporal scales.

Comment: The Conclusion states that "combining multiple datasets is effective," yet the paper currently focuses on the differences between them. Please explicitly describe the proposed workflow or framework for integrating these data sources.

Answer:

While the initial aim was to compare the different approaches and highlight their respective strengths and limitations, our analysis indicated that combining the datasets provides a more comprehensive understanding of the underlying processes. We will clarify this evolution in our line of reasoning in the revised manuscript to make the rationale and methodological development more transparent (see section 5.2).

Comment: I encourage the authors to explicitly highlight the importance of these findings for decision-makers, emphasizing how remote sensing can inform regulatory control and policy updates.

Answer: We will place greater emphasis on the significance of these results in both the discussion and conclusion sections to better highlight their relevance within the overall study (see section 6).

Comment: In paragraph 35, "unregulated" and "artisanal" are treated as synonyms. Note that artisanal mining can be legal and regulated. Please refine the terminology to reflect legal distinctions.

Answer: It was not meant to be treated as synonyms, but we can see how it seems like that in the text, we will correct that passage.

Comment: All figures are pixelated. Please ensure all graphics are provided at a minimum resolution of 300 dpi.

Answer:

The figures appear pixelated in the PDF version, despite being exported at 300 dpi. We will address this issue by ensuring that image quality is preserved throughout the conversion and export process, so that high-resolution figures are retained in the final manuscript.

Comment: Ensure all citations (e.g., Plan V, 2024) are included in the final reference list.

Answer:

We will go over the reference list and make sure all citations are included.

Dear Anonymous Referee #2,
Thank you for your valuable feedback and constructive comments. We appreciate the time and effort you have spent reviewing our manuscript. In the following, we address each of your comments in detail.

Comment: The definition of the AOIs, although it describes their limits, is not clear. Why are the AOI borders straight (in case of South Napo), while in other cases they are sometimes curved or angular? Were geographical or administrative marks used? This issue has a central implication on the results (as presented in Fig.4), as the quantification of vegetation loss is displayed in relative terms (percentage of the AOI). If the limits are arbitrary, then the way the results are presented should be reviewed.

Answer:

We will further clarify the logic for the selection of our AOIs in the revised manuscript. We acknowledge that the curved boundaries of the overview AOIs are not optimal for interpretation, and we will revise them to simple rectangular shapes, as they primarily serve as a contextual overview for the more detailed Sub-AOIs.

The Sub-AOIs represent the main analytical units of this study and are therefore the focus of the delineation. Importantly, they are not randomly selected but are based on reports and other coarser-scale sources identifying known mining areas. Given that the applied methods are also sensitive to other types of land-cover change, the study deliberately focuses on areas with documented unregulated mining activity to ensure a targeted analysis. We will revise the manuscript accordingly to make this hierarchical AOI design and its justification more explicit (see Fig 1).

Comment: In the sentence in line 81 it is not clear whether "area" and "province" refer to the same spatial unit.

Answer:

We can see that the phrasing may have led to some confusion. In this context, "Area" and "Province" refer to different spatial units. The intention of the sentence was to indicate that the three AOIs analyzed in this study are located in different provinces of Ecuador. We will revise the wording in the manuscript to make this distinction clearer (see section 2).

Comment: It's not central to the manuscript, but the underlying assumption expressed in line 53 that RS ensures objectivity can be often misleading (see, for ex. https://journals.sagepub.com/doi/10.1177/03091333241248055). It is understandable from where this perspective comes, but it's always important to keep a critical view on RS and objectivity while dealing with human-nature relationships under specific political regimes.

Answer:

We appreciate this important remark. However, the focus of this manuscript is not to assess whether remote sensing is always applied in an objective manner by all users, but rather to demonstrate that remote sensing data can be effectively used and is often readily accessible for the detection and monitoring of unregulated mining sites. We acknowledge that this does not imply that the data or its application is inherently objective, and we will clarify this distinction more explicitly in the revised manuscript to avoid potential misunderstandings.

Comment: In line 198, when mentioning the intra-annual variability, it is important to mention if seasonality has any effect on the measurement, especially in relation to water bodies. Or, in general, if the results could be impacted by other types of activities occurring in the region (small-scale agriculture, forest extractivism, etc.)

Answer:

We will add to the manuscript that normal seasonal variability does not have a significant effect on the results. However, we acknowledge that it cannot be stated with certainty that all detected deforestation is exclusively attributable to mining activities.

We will therefore explicitly address this limitation and discuss the potential influence of additional contributing drivers in the interpretation of the results (see section 5.1).

In this study, we assume that the detected deforestation is primarily associated with mining activities. This assumption is supported by the pre-selection of AOIs based on reports and external sources such as MAAP (https://www.maapprogram.org/) or the Amazon Mining Watch (https://amazonminingwatch.org) documenting unregulated mining, as well as the consistent presence of characteristic mining-related features such as water-filled pits across all scenes.

Comment: Although not central to the argument of the manuscript, the arguments presented in the discussion section are a bit vague. Some of the claims could be backed by literature, as for many claims, a body of literature has already been produced (gray literature is a valuable source to support the author's point, even the one produced by MAAP). For example, the assumption that high prices increase deforestation (https://iopscience.iop.org/article/10.1088/1748-9326/10/1/014006)

Answer:
We acknowledge your point and will strengthen the manuscript by providing additional support from relevant literature and data sources for the statements made.

Comment: The sentence beginning with "while" in line 46 needs revision, because it calls for a second clause which is not present.

Answer:

Yes, that will be corrected.

Comment: Fig 1 (or elsewhere) would benefit from including an indication of the settlements mentioned in the paragraphs before, which would enable a better understanding of the human-environment relationship (anthropogenic pressure).

Answer:

We appreciate this suggestion and understand the value of including settlement information for interpreting human-environment interactions. However, we think that adding a settlement map would not directly support the primary focus of this study and may instead introduce unnecessary complexity and potential confusion in the presentation of the results. While such a map could illustrate whether mining activities occur in proximity to settlements, the focus of this work is not on settlement exposure or impact assessment. Including this layer could unintentionally imply that mining impacts are primarily localized to mining-adjacent areas. This would risk underrepresenting the broader and often spatially extensive consequences of mining activities.

Comment: In line 120, it is mentioned that "unsupervised clustering proved unreliable"; it is not clear if it was the author's previous experiments or from the literature.

Answer:

That is based on previous experiments, and this statement will be added to improve clarity (see section 3.1.1).

Comment: I suggest indicating what "cmap option" entails. The text assumes the previous knowledge of the reader.

Answer: We will include an explanation of the cmap option and possible other available settings provided by the tool.

Comment: In Fig 5 is mentioned "the proportion of AOI affected", but in this case, for what the reader can understand, what is represented is the absolute number, not relative.

Answer:

Correct, the figure only shows absolute data and that will be corrected (see Fig 4, Fig 5).

Comment: Fig 6, the legend describes the results by left and right, while only one image is divided like that.

Answer:

You're correct, that is an artefact from a previous version and needs to be corrected.