Critical methodological flaws in Feurer et al. (2025) render its findings untrustworthy

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Introduction

We appreciate the effort by Feurer et al. (2025) to synthesise literature on the drivers of deforestation and forest degradation globally. The stated aim of the review, to assess what are the proximate causes and underlying drivers of deforestation and forest degradation worldwide, is timely and relevant for ongoing policy efforts, for example zero-deforestation commitments and EU Deforestation Regulation (EUDR). However, the review has severe methodological and conceptual flaws that render the findings untrustworthy and unusable. We summarise our three main concerns below, show the findings from a risk of bias assessment, and suggest a tool for editors and peer-reviewers to evaluate review quality.

1. Mischaracterising the review as a systematic review and meta-analysis

Feurer et al. describe their synthesis as a "systematic review and meta-analysis". However, they have not conducted meta-analysis (a powerful and vital quantitative synthesis method) by any accepted definition. Specifically, their analysis does not estimate and summarise effect sizes nor quantify differences in the magnitude of drivers. Instead, they simply report the frequency with which drivers are mentioned across included articles. Presenting frequency counts as an indication of relative importance risks implying causal weight that the data do not support and may further amplify publication bias, as frequently studied or reported drivers will appear disproportionately influential irrespective of their true effect.

The fallacy of this approach is easily demonstrated. In their analysis of deforestation caused by oil palm plantations, Lee et al. (2014) compared the magnitude of forest loss between smallholdings, private enterprises and state-owned oil palm plantations in Sumatra. Private enterprises were responsible for 88.3% of the total deforestation compared to 10.7% by smallholdings. Following the logic of Feurer et al. both commercial and smallholder agriculture would get one mention as deforestation drivers, but in truth, commercial agriculture is in this case nine times more impactful. Furthermore, as Bernhard et al. (2024) demonstrate, methodological approach and scale of analysis influence the quantity and type of drivers identified. Feurer et al. do not account for this at all. Without conducting a proper analysis, the magnitude of impact and what are the most impactful drivers is not known.

2. Misconduct in the review process

The authors state that they conducted the review according to the guidelines by the Collaboration for Environmental Evidence (CEE). This is not the case for reasons we outline here: The authors did not publish *a priori* protocol nor is their method section transparent and clear enough for the review to be replicated. Their search strategy has several flaws which mean the search is neither transparent nor replicable. Full line by line searches detailing use of search functionality within each database, such as controlled vocabulary, Boolean operators, phrase searching, and truncation, are missing. Also, the authors provide no evidence of validating the search string. Standard practice would involve evaluating the effectiveness of the search to retrieve records based on a set of clearly eligible benchmark studies. The failure to evaluate the effectiveness of the search has implications for the review as we demonstrate below.

Further, the authors do not list specific sources and year ranges covered. 'Web of Science' and 'Ovid' are listed as databases which is not correct, these are platforms which give access to many individual databases. When we run a topic search in the Web of Science Core Collection database limited to 1 Jan 1990 to 19 June 2023, we get 19,737 hits compared to their 4,207 hits. The goal of evidence synthesis is to gather all (in practice, a maximum number of) relevant evidence on a research question, while minimising biases in the process, to provide a

reliable answer. Comprehensive and well conducted searches are the foundation for the rest of the evidence synthesis. Failing to identify and include relevant articles can significantly affect the findings and cause bias in them (Konno & Pullin, 2020), which is the case here.

A previous review on deforestation drivers in the Amazon biome (Hänggli et al., 2023) identified 7401 unique articles in English published between 2000-2021. Through screening this was reduced to 150 included articles with 426 cases in the Amazon alone. In contrast, Feurer et al. included only 159 studies across the whole humid and semi-humid forests. The lack of comprehensiveness from Feurer et al. leads them to find that "*commercial agriculture also entails livestock and pastures, which were responsible for forest clearings in 34 articles but usually as a secondary cause".* The more comprehensive and methodologically rigorous review from Hänggli et al. concludes: "*Pasture expansion was the primary proximate cause of deforestation in the Bolivian, Ecuadorian, Colombian and Brazilian Amazon across the entire period".*

Another review by Bernhard et al. (2024) on tropical deforestation drivers included 231 articles. Of these only 31 articles were included in Feurer et al. even though both reviews deal with proximate and underlying drivers of deforestation (see Annex 1 for articles included by Bernhard but not by Feurer et al.). Without conducting a rigorous systematic review, it is impossible to know the extent of evidence base Feurer et al. missed and the bias contained in the findings. However, these examples demonstrate that clearly a significant amount of the evidence base is missing from Feurer et al. In the case of Bernhard et al. the number of articles not shared by the reviews is larger than the number of included articles by Feurer et al. Consequently, the number of missing articles is large enough to change the findings.

Additionally, excluding grey literature such as FAO or World Resource Institute's reports, introduces publication bias. For example, a report by Goldman et al. (2020) identified the extent to which seven commodities—oil palm, soy, cattle, plantation wood fibre, cocoa, coffee, and plantation rubber— are replacing forests and mapped their role in causing deforestation. They conclude that cattle replaced the most forest by far (63% of the analysed commodities) in land deforested between 2001 and 2015. Their data comes from an article by Curtis et al. (2018) that looked at drivers of global forest loss using satellite imagery – an article that Feurer et al. seem to have missed with their search strategy. Both Curtis et al. and Hängli et al. are spatially explicit analyses and further demonstrate the fallacy of equating study numbers with magnitude of effect.

The authors use the PICO (Population–Intervention–Comparator–Outcome) framework to define inclusion criteria. PICO is designed for questions looking at intervention effectiveness. In this review, no intervention is being evaluated. Instead, drivers are explanatory factors and there is no comparator. To make matters worse and highlighting the lack of conceptual and methodological understanding, the authors name deforestation as the outcome of interest when the true outcomes in this review are the underlying and proximate drivers. As a result, the review conflates explanatory factors with outcomes, obscuring the causal relationships it seeks to explain and limiting the usefulness of its findings. Further, the article selection and data extraction were conducted by a single reviewer without duplicate screening or inter-rater reliability checks. This increases the risk of selection and coding bias, particularly when driver categories require interpretive judgment. For example, Feurer et al. include a study by Agduma and Cao (2023). The stated aims of the study are "*to database true mangrove species in SBPS; map the extent of mangrove forests; and examine the potential threats to mangroves in SBPS".* It provides a snapshot data of the current land use cover from 2022 rather than deforestation or forest degradation data. Furthermore, the authors explicitly state that they provide a preview of potential threats (i.e. things that might happen in the future). Inclusion of this article goes against the statement that Feurer et al.

removed studies that did not explicitly focus on deforestation or forest degradation. Inclusion of this article demonstrates the lack of conceptual understanding (confusing threats with drivers/causes) and the risk of selection and coding bias that has implications to the findings.

Also, Feurer et al. did not conduct critical appraisal of study validity, which is essential part of systematic review process to ensure that the review's results are reliable. For example, they included a study (Abugre & Sackey, 2022) that has a clearly biased study design and statistical analysis. In Abugre & Sackey (2022) all variables including "deforestation" are based solely on respondents' perceptions, which introduces strong "common-method bias" (the way that the data was collected creates artificial correlations between variables) and prevents any link to actual forest loss. The sampling strategy is non-random and mixes community respondents with forestry officers, making results unrepresentative and potentially skewed. Finally, the Partial Least Squares path model is applied to cross-sectional self-reported data, producing path coefficients that reflect shared beliefs rather than real causal relationships. As a result, the study cannot validly claim that any factor has a "direct" or "indirect" effect on deforestation.

Finally, the authors do not report the conduct of the review against reporting standards, such as ROSES (Haddaway et al., 2018). All these elements are clearly outlined in the CEE evidence synthesis guidelines (Collaboration for Environmental Evidence, 2022a), and all contribute to increase risk of bias in the review findings. A formal assessment of the risk of bias in the review conduct and reporting can be found in Table 1. It shows serious deficiencies in conduct and/or reporting in nine out of 16 criteria and deficiencies in the remaining giving an overall assessment of little to no confidence in the findings. We recognise that it may not be easy for editors and peer-reviewers to evaluate review quality and identify whether a review can be called a **systematic review,** which is **a recognised and clearly defined form of evidence synthesis**. This is not a new problem, but it is becoming a problem at a scale that threatens the validity of science within environmental decision-making. To aid editors and peer-reviewers in the evaluation, CEE has published a simple checklist that can be found here: https://environmentalevidence.org/wp-content/uploads/2021/02/CEESAT-Checklist-for-editors.pdf

3. Conceptual decisions and terminological mistakes that influence the findings

The review excludes studies addressing spatial and structural forest change, including fragmentation. This exclusion narrows the scope of considered forest change dynamics and shapes the types of drivers included. Fragmentation is a central process in forest degradation, forest cover changes, and land-use transitions (Ma et al., 2023). Logging roads and sites cause forest fragmentation and degradation and often precede deforestation (Matricardi et al., 2020). Furthermore, ecologically, it is not only the amount of forest that matters. It is also the quality and distribution of forest. Forest fragmentation leads to smaller forest patches, increased number of patches, and more forest edge, which have negative implications for forest species (Barlow et al., 2016; Pfeifer et al., 2017). Omitting fragmentation limits the completeness of the findings and causal mechanisms behind deforestation. Another conceptual decision Feurer et al. make is to include conversion of a natural forest to a planted forest as degradation rather than deforestation. This decision does not align with aims of many policies and initiatives to conserve natural forests for their biodiversity and carbon benefits. Nor does it make sense ecologically, especially when non-native tree species are used to replace natural forest. Eucalyptus plantation in place of natural forest is not a degraded natural forest, and it could not be restored to a natural forest state just by leaving it untouched. The restoration process would be akin to oil palm plantation or any other agricultural commodity and therefore, the decision to classify planted forests as degradation introduces bias to the findings as tree plantations themselves may be, and in practice also are, drivers of deforestation.

Finally, we have concerns of misclassification based on terminology. For example, Feurer et al. discuss the challenge of distinguishing between subsistence and commercial farming. They refer to terms such as 'subsistence mixed farming' and reference Yadeta et al. (2022). However, 'subsistence mixed farming' as used in Yadeta et al. refers to growing of crops and rearing animals rather than mixing subsistence and commercial farming. This example also serves to highlight once more why systematic reviews have steps to verify construct validity and understanding among authors rather than rely on single-person screening.

Conclusion

Here we have demonstrated that the review by Feurer et al. (2025) does not meet the methodological standards required of a systematic review with a meta-analysis and have given examples of bias in the findings. By mischaracterising the study design, employing an incomplete and non-transparent search strategy, conflating key concepts, omitting critical appraisal step, and relying on single-reviewer screening and data extraction, the authors introduce substantial risk of bias at every stage of the review process. The result is a synthesis that does not reliably represent the underlying evidence base and that generates conclusions at odds with more comprehensive and methodologically rigorous analyses. These shortcomings are not merely academic. They risk misdirecting policy and evidence-based decision making.

Table 1. Assessment of the risk of bias in the review conduct and/or reporting using the Collaboration for Environmental Evidence Synthesis Appraisal Tool (CEESAT) (Collaboration for Environmental Evidence, 2022b)

Question	Risk of bias	Explanatory notes
Are the elements of the review question clear?		PICOs wrongly defined
Is there a protocol?		No protocol and no clearly defined methods section.
Is the search clearly defined?		No information about the actual databases, just platforms.
Is the search comprehensive?		Few sources and few terms. No grey literature.
Are eligibility criteria clearly defined?		PICOs wrong and criteria not specific.
Is eligibility criteria consistently applied?		Only single author screening, no consistency checking
Are eligibility decisions transparently reported?		Reason for exclusion not reported for each article.
Was each study critically appraised?		No critical appraisal conducted
During critical appraisal was effort made to minimise subjectivity?		No critical appraisal conducted
Is the method of data extraction fully documented?		Not replicable based on information provided.
Are the extracted data reported for each study?		Data per study not reported
Were extracted data cross checked by more than one reviewer?		Only single person extracted the data. No cross-checking.

Is the choice of synthesis approach appropriate?		No. The authors call the analysis meta-analysis, but it is not.
Is a statistical estimate of pooled effect (or similar) provided together with measure of variance and heterogeneity among studies?		No statistical estimates provided.
Is variability in the study findings investigated and discussed?		Not investigated as this is a systematic map rather than systematic review with meta-analysis.
Have limitations of the synthesis been considered?		Limitations of the review conduct not considered.

Legend for the risk of bias ratings

	Meets the standards of conduct and/or reporting that reduce risk of bias as much as could reasonably be expected. Lowest risk of bias – high repeatability – highest reliability/confidence in findings.
	Acceptable standard of conduct/reporting that reduces risk of bias. Acceptable risk of bias – repeatable – acceptable reliability/confidence in findings.
	Deficiencies in conduct and/or reporting standards such that the risk of bias is increased (above green), alternatively risk of bias may be less easy to assess. Medium risk of bias – not fully repeatable – low reliability/confidence in findings
	Serious deficiencies in conduct and/or reporting such that risk of bias is high. High risk if bias – not repeatable – little to no confidence in findings

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