

## ***Interactive comment on “Diverging land-use projections cause large variability in their impacts on ecosystems and related indicators for ecosystem services” by Anita D. Bayer et al.***

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This study analyzes 16 scenarios from five land use models (LUMs) and integrated assessment models (IAMs) and the effects of the resulting land use changes towards 2040 on ecosystem service (ES) indicator values. The text is easy to read, the work is well-embedded in existing literature, and the results are visualized comprehensively. I have two main questions/concerns with respect to this study, as detailed below.

**Model-coupling mismatches:** To my understanding, you use a one-way coupling between the LUM/IAM and LPJ-GUESS. This can lead to mismatches. For example, the IAM has computed production of particular agricultural products for a region, and con-

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verted this into a cropland area per grid cell. In LPJ-GUESS, this grid cell contains a prescribed fraction of crop functional types, which can mismatch with the products in the IAM, and a certain yield, which can mismatch with the production (supply) of agricultural area of that grid cell in the IAM. I believe that such mismatches have a large effect on the results. I expect that large differences in ES indicator values between two models will occur when one of them has a good match with LPJ-GUESS (due to the use of the same data sources) and another a bad match. The comparison between ES indicator values is not fair in this case, because for the second model, its assumptions are violated by the LPJ-GUESS model (for example, demand in the IAM does not match supply computed by LPJ-GUESS). I think it would help to explain how the models are coupled exactly (what variable(s) is/are exchanged) and to bring this point up in your discussion if you agree with this potential issue.

**Scenario projections:** It is recognized that LUMs/IAMs do not provide predictions (as weather predictions do), but instead projections, meaning that they are conditional (what if ... ?). What conditions are evaluated depends on the question at hand. The conditions can range from realistic (business as usual) to very unrealistic. Unrealistic scenarios can still be useful as thought experiments, to better understand the system, to serve as warnings for worst-case effects, or to evaluate potential policy interventions. As such, in lines 487 and further, you discuss that some scenario results don't seem plausible. But perhaps they aren't meant to be plausible. Therefore, given that the conditions, and thus the scenarios, depend very much on the question asked in the original study, it is not clear to me what you are exactly evaluating when assessing the variation in ES indicator outcomes over all these models and scenarios combined. I could see the added value of analyzing ES indicator outcomes of all business as usual scenarios, as that would show the effect of different assumptions about the working of the current system on ES impacts, but the value of comparing among the other scenarios (which could have easily been very different if a different question were asked) is not quite clear to me. In the current version of the manuscript, you only comment about this seems to be "However, conclusions drawn here in regard to projected changes

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in LULC and ES indicators are inherently dependent on the selected set of LUMs and scenarios, evaluation time period and simulation set-up", which does not really help the reader to see what can and cannot be learned from the results given this dependence.

Minor comments:

481-486: In the context of this paragraph, which speculates about the potentially more valid small-scale changes of some of the models, you may be interested to know that, in a recent study of LUC in Brazil, we found that indeed the small-scale changes of a spatially-explicit LUM were more accurate than the larger-scale changes of an economic model, see Stepanov et al. 2020, doi:10.3390/land9020052

691-692: "We conclude that LUMs and IAMs have fundamental limitations in capturing all relevant processes related to LULC changes." I don't see how your results lead to this conclusion.

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