

## ***Interactive comment on “Impacts of future agricultural change on ecosystem service indicators” by Sam S. Rabin et al.***

### **Anonymous Referee #1**

Received and published: 24 September 2019

This article presents an ambitious modelling exercise that combines the LPJ-GUESS dynamic global vegetation model with the PLUM land-use model (now under the new name LandSyMM). While the model has been presented before in Alexander et al 2018, the coupled models have not been presented before from the LPJ-GUESS perspective which makes this an interesting article. Additionally, the large number of ecosystem service indicators make the presented analysis interesting on its own.

Before the article can be published in ESD however the structure of the article needs substantial improvement. While I acknowledge the challenge of describing such a complex model in a comprehensive as well as concise manner, I do think improvements can be made. I have three general points and a number of more detailed points that need to be addressed:

- The structure of the methods section is confusing. I would recommend to start with an overview of the models used and how they interact (a diagram might be helpful), then a detailed description of the different ecosystem service indicators analysed. Also, I would recommend to reduce the size of the methods section by moving some of the information on detailed input for LPJ-GUESS and PLUM to the SI. On the other hand, much more information is required on the scenario setup. Details about the main assumptions should be presented. A table with an overview would be helpful. It is important that the reader does not depend on a different article to understand how the presented scenarios are defined.

- The extra experimental scenarios that have been performed to improve understanding of the results are confusing. Maybe these can be added to a descriptive scenario table, either in the main text or the SI, and they could be given explicit names to make it easier to refer to them in the results section, e.g. SSP4-2.6-noCO2/noLUC. I think this is better than for example the long text 'in the constant climate+CO2 experiment' (line 295-296).

- The results and discussion section is rather lengthy and is (as the names correctly states) a mix between results and discussion. I think this reduces the clarity of your story and is not in line with the standard outline of scientific articles. I think the article would greatly benefit from splitting up this section into a clear description of the results (topic by topic) and subsequently a discussion of the results in the context of the literature (again, topic by topic).

Detailed comments:

Line 9-10: this is the first time biodiversity is mentioned in the abstract, while it is presented as one of the major outcomes.

Line 15: please rephrase 'larger than today's by anywhere from' to something more concise and more academic, e.g. 'an increase ranging from 1.5 billion to 6 billion'

Line 57-102: this section describes the ecosystem service indicators presented in the

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article. This should be a separate section. In addition, a lot of the text is introduction to why these indicators are important. I think this reduces the clarity of the methods section which should be a more technical description of the indicators presented in the article. Maybe you can move part of the text (in a more concise way) to the introduction.

Line 93-102: I assume the biodiversity indicator is not a standard output of LPJ-GUESS, correct? It is now part of the LPJ-GUESS section which is misleading. It should be more clear that this is calculated based on the downscaled PLUM results.

Line 109-110: The Popp et al 2017 article describes a large number of SSP scenarios from 5 IAM models. Please specify which scenario from which model has been used and preferably refer to a paper that presents the results specifically for this model.

Line 115: this is a very detailed start of this section. Consider restructuring the sentence. Maybe move this entire section to the SI as very detailed information for main text.

Line 137-138: a summary of the climate and land use data used should be given in the text, not in the SI. Consider moving this text to the SI and summarizing input data in the main text.

Line 161: make sure your language is more academic. Don't use terms like 'briefly' or 'attempts'.

Line 178: what is minimum 'non-agricultural area'. This sounds like a PLUM-specific technical term, please rephrase.

Line 203: 'cropland area expands about 10% between 2050,...'. Between 2050 and what?

Line 214: 'what PLUM calls "other management"'. Please use more academic language and avoid usage of model-specific technical terms.

Figure 1: why do you only show ruminants? Non-ruminants also have a very strong

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effect on the agricultural system due to high feed requirements. Also, I am surprised about the very strong increase in ruminant demands. FAOSTAT actually shows that in recent decades demand for ruminants-based products has increased relatively little while monogastric-based products have increased much stronger.

Line 243: I was taught to avoid the term 'forecast' (sounds like something a fortune teller would say) but rather use the term 'project', but maybe this is a personal preference.

Line 251-252: this sentence is extremely vague and unhelpful. Please make more explicit.

Line 276: it is impossible to have 500% or 700% higher land use, using current agriculture (~50 Mkm<sup>2</sup>) this would mean 250 or 350 Mkm<sup>2</sup> which is more than the terrestrial area of the world.

Line 282: what do you mean with infrastructure efficiency? Also, if I understand correctly you make similar SSP-specific assumptions in PLUM (SM6). These should also lead to a higher spread in land-use projections, right?

Line 276-278: I don't see why the RCPs lead to a much larger spread in scenario results? Also, is PLUM informed about the yield effects of climate change as these would impact for example trade and food security?

Line 325: is this realistic? Could not reduced feedback effects from lower evapotranspiration from forests in fact reduce runoff?

Line 336-337: how can increased agriculture reduce the risks on droughts? Please explain.

Line 348-349: I do not understand what the 'fraction of included land area' means and why it shows that not including routing is not a big issue (it sounds disconcerting to me). Please explain better.

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Line 359-360: why is the estimate more consistent if there is less over application of N? In reality many countries exceed the N uptake rate of plants (most notably China). It sounds less realistic to me that N application only increases by 2%. Does this not imply a major break with historical trends?

Line 369-370: you cannot state 'and other models' here if you refer to three articles that are if I am not mistaken all based on LPJ-GUESS. It is quite logical then that the estimates are similar. Please add an independent reference.

Line 430: I don't think 'storylines' is the right word here as you don't calculate storylines but scenarios that are described by a certain storyline.

Line 435-439: would it be possible to draw stronger conclusions based on the scenario assumptions on how certain future developments should rather be avoided etc?

SI:

Figure SR2: why are the starting points in 2010 so different for irrigation and fertilizer? This should be historic data I assume? Also, there is hardly any trends in the irrigation results, why is this the case?

Figure SR3: I don't understand the top figure on livestock demand. The order of magnitude makes it likely the results are on crop production, but the title suggests this is total production (?) of livestock products. But the bottom figure shows feed for livestock so if the top figure is also about feed demand for livestock it would not be useful. Please explain and improve.

Figure SR8: similar figures are shown for south asia and sub-saharan Africa. Why not consistently show results for all regions? Maybe in slight smaller panels and without the figures with maps in between? Also, why is this figure shown as a delta instead of absolute amounts and how can it be that the demand is so extremely jumpy for oil crops? This seems very unrealistic.

Figure SR10: please write complete description instead of referring to another figure.

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