

Interactive comment on “Development and testing of scenarios for implementing Holocene LULC in Earth System Model Experiments” by Sandy P. Harrison et al.

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Received and published: 14 November 2019

This is a well written paper that describes possible ways forward to improve historical land use change estimates, globally. Improving reconstructions of land use change is critical, given its impact on past vegetation cover, climate change, carbon cycle. And while the observational data-sets to undertake this endeavour necessarily are limited it is nonetheless a crucial starting point.

Some of my questions below arise most likely from being interested in land-use change but I'm not a paleo-expert. Most importantly, some paragraphs/(sub)sections of the paper could gain by providing a little bit more detail 'how' exactly the new approach will

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be put in practise and how exactly the improvement might be envisaged.

Before I get into these there is one major aspect that seems missing from the approach. People need not only to eat, they also need to cook and heat, and to live. Has the group not discussed to -in addition to archaeological data- to also mine written historical records? This is probably most relevant for the last 1000+ years (rather than mid-Holocene), but surely there can be assumptions about wood requirements for building materials (analogue to a per-capita area needed to be fed: how many people would live in an 'average' house/farm and how much would this would need), shipping fleets (records from shipyards), charcoal making, furnaces for metal forging etc. I would imagine that at least in some regions this would have contributed perhaps already many centuries ago to deforestation. Could the authors comment on this aspect? To me this seems an obvious next step.

Lines 63-65: For correctness, I would avoid using the term “feedback” here in the sense of change in process A affects process B, feeding back to A. LUC impacts on the carbon cycle are nothing more than an additional emission (or uptake), similar to other anthropogenic emissions, and the biophysical processes are related to albedo or ET change – but these are not feedbacks.

Lines 89-99: might be worth pointing out that the large discrepancies between Hyde and KK10 arise mostly from the assumptions about per-capital land requirements; to my knowledge their estimates of historical population changes through time (at least global totals) are more or less the same.

Lines 125-132: Given that these MIPs are already well under way, could you pls comment how realistic it is that the communities will be able to take up these protocols in time? Is it not more likely that the work will be most useful for many other studies that may not follow the tight schedule of the current AR6 MIP-frenzy, including work that would be useful also in context of the IPBES; and/or might feed into the next IPCC cycle ? Lines 141/142: style; one 'required/requirements' might be sufficient...?

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Figure 4: 'Wetland cultivation' in Level 3 – would that mean wetland drainage for agriculture? I assume it does, please clarify.

Lines 146-162 – bit of an unspecific list, can be more precise, give more concrete examples?

Section 3.1 – this section wasn't entirely clear to me. What samples are we talking about exactly, what is being dated, where do the samples come from? Could you provide an illustrative example?

Figure 5: I liked the Figure, is nice to see a concrete, illustrative example of the planned approach. However, it was not entirely obvious to me what the top and bottom panels in Fig. 5 are meant to convey: is it to show the improvements that can be made by adding the new information to the existing LandCover 6a? Or what is exactly the added value of the two combined? And what's the reasoning behind the 10-15% and the 5% mentioned in lines 269/270?

Lines 288/289: how do you obtain information about past irrigation? From archaeological data (irrigation structures?) I assume? Likewise, per-capita land needs surely change over time, agreed. But how can these estimates be obtained, could you provide more explanation and/or references to methods as to how to do this?

Figure 6, just for illustrative purpose only: the panels 'land use classification input' and 'revised land use allocation' look identical, might be illustrative to not only change the legend but also the drawing. Line 327-329: what's the basis for the optimism that 'eventually' these pollen-based reconstructions will also be available elsewhere (presumably: the tropics), is there initial work that points in that direction? And what's the pros/cons of the "other" pollen-based reconstructions that are mentioned?

Lines 385/386: "known" today is not quite true unfortunately. There are still sizeable discrepancies in today's land cover estimates in terms of major classes such as cropland, pasture, forest, 'other' (let alone in the degree to which these are being used).

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Partially this arises from disagreements in terms of how a pasture or forest is defined. There is no need to add a long discussion but pls. revise the sentence slightly to express that there is also uncertainty for today.

Lines 383-399: The scaling aspect is important. However, cumulative LUC C emissions differ substantially depending on whether "net" or "gross" area changes are being calculated. The total agricultural area might be the same in both approaches, but the 'gross' approach considers expansion and reduction that might occur within a gridcell. The most prominent example is shifting cultivation, and today is mostly restricted to tropical regions. However, others have pointed out that such gross transition of course also are relevant on other parts of the world (see e.g., Fuchs et al., GCB, 2015), and were possibly even more so further back in time. The challenges that arise from this aspect are mentioned later in the Outcomes section but I wonder if it's not better to introduce these already here.

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-125>, 2019.

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