

Earth Syst. Sci. Data Discuss., community comment CC3  
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## Reply on CC2

Malte Meinshausen

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Community comment on "Harmonising the land-use flux estimates of global models and national inventories for 2000–2020" by Giacomo Grassi et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2022-245-CC3>, 2022

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**Hi Sandro,**

**Good to e-meet you again this way. As there are many questions in your reply, I just reply inline here (marked with >> REPLY).**

Interesting discussion,

Best,  
Malte

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The issue is not just "political".

**>> REPLY: Agree.**

Methods to deal with terrestrial C pools contributions to atmospheric CO<sub>2</sub> concentration must address 3 fundamental requirements:

- **counts what the atmosphere actually sees as a consequence of human activities.** Here is worth noting that:
  - the consequences of human activities are direct and indirect, and both in the liability of human actors, and
  - it looks not sensible (not just politically) to ask to exclude the indirect effects of human activities from the mathematics that has been set to deal with the most dangerous of the indirect effects of human actions: Global Warming.

**>> REPLY:**

- **I agree with the general statement of "the accounting has to reflect what the atmosphere sees".**

- **I disagree with the interpretation of that notion, though. The atmosphere sees the full amount of direct emissions. It is then the response of the Earth System, i.e. the carbon cycle that responds to our perturbation. Netting the direct emissions with parts of the indirect responses is what "the earth system makes of it", not "what the atmosphere sees".**
- **According to your logic (if I understand correctly), one should mix the direct anthropogenic emissions plus the natural re-distribution of carbon into its different pools, then – taking that logic to an end – we should only report emissions that sum up to the total direct anthropogenic emissions times the (time-changing) airborne fraction. In other words, if we should "take credit" for all the indirectly induced sinks, then we basically report emissions that reflect the atmospheric concentration changes. A large fossil fuel emitter could argue that 25% of its emissions are taken up by boreal forests. And 25% are taken up by the ocean. Hence, he only reports 50% of its emissions. (And yes, I know, we had countries in the UNFCCC who made that argument).**
- **Following the same logic becomes even more odd, when we we look at methane emissions, for example. If you both report emissions plus indirectly enhanced sinks (in the case of methane for example the enhanced sink via OH), then we would report zero emissions (if we choose a long enough timeframe) – given that methane has a finite lifetime. (and yes, I know, some people have even argued for that).**
- **And is it then the boreal forest country claiming credit for the CO<sub>2</sub>, the country with the coastal ocean waters where some CO<sub>2</sub> is taken up, or is it the fossil fuel emitter, without whose emissions we would not have the elevated CO<sub>2</sub> emissions in the first place and hence we wouldn't have any indirectly enhanced sinks?**
- **Or, following your logic, will boreal forest owners then start to report all the climate-change induced wildfires as their national emissions? Will Brazil claim responsibility for any Amazon dieback triggered by climate change? Those emissions are also "indirectly human-induced". But I doubt that northern boreal countries would want to claim responsibility for climate-change induced wildfires, or permafrost thawing related emissions, or methane clathrate thawing in their coastal waters and forgo the "force majeure" rules.**
- **Thus, not only does the mix of directly and indirectly human-induced emissions not add up to "what the atmosphere sees", but also leads to an asymmetric accounting, if humanity happily takes credit for some of the natural carbon sink responses to the human perturbation, and not take responsibility for the indirectly enhanced sources.**

Thus, the only logical reporting from a climate science point of view is to strictly try to delineate between direct anthropogenic emissions (and sinks) and indirect ones. And, following that logic, countries should report the directly human-induced emissions and additional removals, not any indirect ones.

- **be verifiable.** This is the main challenge that models applied for reporting under the UNFCCC must address

**>> REPLY: Agree on that one. And that is indeed a challenge in the land-use sector – for multiple reasons (as you know better than I do):**

- **Measurement difficulty of above and below ground carbon to start with**
- **Natural variability (i.e. drought/wet years and respiration effects etc)**
- **And then – on the topic – separation of directly and indirectly induced carbon**

pool changes.

**Thus, not bothering about the last point of course makes the measurement “more verifiable”, but not necessarily “verifiable per se..”, meaning that the first two points still create sufficiently big headaches that labelling land carbon pool changes as clearly verifiable remains a bit of a stretch in any case. But yes, we can operate with some verifiable activity data and emission factor assumptions etc. Luckily, your study makes the comparability and verifiability a bit easier with regards to point c.**

- symmetrically applies to the 2 sides of the same coin, CO2 removals and CO2 emissions

**>> REPLY: So, countries should start to include climate-change induced wildfire emissions into their NGHGI? Amazon dieback? Permafrost thawing? While that would make it symmetric, it is then a question of regime stability and assigning responsibility to indirectly induced effects to the territory where these indirect effects occur.**

Then, let me note that:

- forest growth is the result of direct and indirect human-induced effects and (largely prevalent over the other two) of natural variables (and their variability, directly or indirectly affected by human actions; e.g. no rain, no forest growth).

**>> REPLY: No disagreement here.**

- indirect human-induced changes in environmental conditions have impacts on GHG fluxes counted in source categories and sectors other than CO2 from forests.

Thus, shall NGHGI (not just forest land) be based on a fictitious World with standardized conditions where indirect human-induced effects are factored out?

**>> REPLY: Yes, for the big chunk of CO2 fertilization effects. Absolutely. And that it is roughly possible is shown by your study, which is able to calculate the DELTA (i.e. the CO2 fertilization induced uptake on managed lands). That’s why I think the study is a huge step forward, but one should be open about to which side the DELTA is applied. As mentioned before, if the DELTA is only applied to the BMs and DGVMs so that the NGHGI net direct + indirect emissions are taken as the “truth”, then we break the connection to all the physical climate science and its milestones, like remaining carbon budgets, net-zero years etc... But we can just apply the DELTA to either NGHGI or the BM/DGVMs and easily keep the comparability. Thus, in summary, it is great to have the DELTA – and I think your study would be even better if it were agnostic to which side the DELTA is applied. The DELTA calculates the difference and that is what we need to make sense of the difference between aggregate NGHGI and BM/DGVMs.**

If so:

- who is going to set such standards? (there are 25 years of scientific discussion among

authors of IPCC Guidelines on this subject)

**>> REPLY: Yes, and we had a long history of Brazil's interventions in the 2000s on separating out indirect and direct effects – which your study is now able to do. Thus, the scientific advancement of your study is now for the first time able to estimate this DELTA more or less reliably, or not? Anyway, whether the reporting standards are set the one way or the other is, I think, a follow-up discussion. The first important thing is that we get a better handle on the DELTA (which your study does). And that DELTA can be interpreted as a “bias-correction” of the NGHGI, if one wanted to clean them of a big chunk of the indirect effects, or it can (as your study does) applied to the BM/DGVMs. As said above, I argue that your study might want to be agnostic to how the DELTA is applied.**

- how GHG fluxes calculated in a fictitious World would be verifiable with actual measurements?

**>> REPLY: As mentioned above, verifiability is a bigger issue for the landuse sector, not confined to direct and indirect effects. I would disagree with the underlying assumption that by including indirect effects we suddenly have verifiable land-use data.**

As a very easy example, let's take a forest plantation. Who is going to establish the fraction of C accumulation to be attributed to: 1. directly to the human actions as planting/fertilizing/watering(?), 2. the indirect effects (e.g. N deposition, Global Warming) and 3. natural variables (e.g. rain), or at least their variability. And, more importantly, what a country shall count in its NGHGI in case the forest plantation does not grow as expected by counting the direct human action of planting and fertilizing and watering? shall those directly human-induced removals not realized because of indirectly-human induced causes be anyhow counted in the NGHGI? (indeed indirect effects are asked to be excluded from NGHGI so the remaining portion is the direct-human-induced which can be modeled applying standard (?) conditions) and consequently, shall CO<sub>2</sub> emissions sourced e.g. from fossil fuel combustion be offset by such unrealized direct-human-induced removals?

Would be that what the atmosphere sees as a consequence of human actions (this is the definition of anthropogenic; without distinction between consequences reached within the purpose of the action and any other consequences caused)? Would it be considered a sensible approach?

**>> REPLY: Am not quite sure I follow the last question (but that is probably really me): What do you mean by “Shall CO<sub>2</sub> emissions sourced e.g. from fossil fuel combustion be offset by such unrealized direct-human-induced removals?”. In my view that crosses over into the more fundamental “additionality” question and is practically also distinct between afforestation/reforestation and “managed land” areas. Anyway, I won't do your question fully justice, but just some points to consider:**

- If the action of planting a tree only results in meagre carbon pool increase, because the land overall suffers from a (climate-change) induced drought, then I understand your question whether one should give anyway full “credit” for a healthy/ strong growing tree. And no, I would argue one should not, as the additional action only resulted into a meagre additional tree (no matter why the tree is meagre or not). (whether the carbon storage is truly additional over time is a separate debate).

- Anyway, that leads, I admit, to a much longer and nuanced debate on what are the truly additional carbon pool changes and whether the CO<sub>2</sub>-fertilization effect that only acts on

the additionally planted forests shouldn't be counted as well into the "additional carbon pool change". And yes, I can see the argument for that (assuming that without the extra forests, the alternative ecosystem would not have shown a similar CO2 fertilization / uptake). Thus, in some respects, that indirect CO2 fertilization effect on the "additional" tree is itself "additional". It is really the "managed forests", where claiming the CO2 fertilization effect makes a big difference – those managed forests are not "additional", and hence the CO2 fertilization effect that acts on their carbon stock is not "additional". Anyway, this is – I think – an interesting pit hole for many discussions and would lead to a nuanced matrix of additional / non-additional and direct / indirect effects. And so while I agree with you that some indirect effects could indeed be taken as a credit (those that sit in the box of acting on an "additional" carbon pool, where the alternative ecosystem would not have been subject to the same CO2 fertilization effect), the majority of all the CO2 fertilization effects fall into the managed forest area, where the CO2 fertilization effect would have acted whether we "manage" the forest or not.

Anyway, that is an interesting extra discussion, but the DELTA should be reported on its own, and not per se presented as to "correct" BM/DGVM results. It could just as well be seen to correct NGHGI results.

So, considering the urgency to address global warming and the opportunity that the start of a new IPCC cycle gives, I see it urgent for models used for projections in IPCC products to be evolved for consistency with NGHGIs which, in the end, are the only that apply the guidance for good practice in estimating anthropogenic GHG fluxes as approved by IPCC. IPCC will keep moving its mission to keep enhancing its guidance for estimating anthropogenic GHG fluxes according to advances in scientific knowledge and technical capacity.

Please, do not consider this as a response by the authors (it will be given); please consider it just a personal reflection moved by the urgency to move on this subject.

**>> REPLY: I think we agree on the urgency to address global warming.**