Biogeosciences
Discussions

Interactive comment on "Mitigation of agriculture emissions in the tropics: comparing forest land-sparing options at the national level" *by* S. Carter et al.

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Response to: Second referee comments, anonymous. Article: Mitigation of agriculture-driven deforestation in the tropics: comparing land-sparing options at the national level MS No.: bg-2015-79

The authors thank the reviewer for the helpful remarks. These comments suggested improvements to the manuscript which were made by the authors. Our responses to specific points from the review are detailed below.

Reviewer:

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Major Comments:

The authors of the study "Mitigation of agriculture emission in the tropics: comparing forest land-sparing options at the national level" carry out a highly integrative, policy relevant study on the potential for mitigating greenhouse gas emissions through the prevention of deforestation. The authors provide a very interesting analysis that ultimately identifies and prioritizes the most feasible emission reduction options for different countries based on their land use and governance regimes. The study is very timely from both a research and a policy standpoint (it takes advantage of a number of products and demonstrates the integration of interdisciplinary data sources, and provides information that is useful for policymakers prior to the upcoming COP21 negotiations).

This high-level study should be of interest to readers of Biogeosciences. The authors have laid out all of the components of their study in a manner that is extremely clear (both in written form and through flowcharts) and easy to follow, and the approach seems generally sound, though one major comment and some specific comments are mentioned below.

A limitation of this study is that the authors seem to assume zero carbon emissions from the conversion of non-forested land, which may overestimate the mitigation potential of converting this land versus forest. For example, on Page 5438, Lines 11-16, I worry that the authors are, somewhat implicitly, presenting a rather black and white view here of the forms of land conversion that are of concern from a mitigation viewpoint. It is important for the authors to discuss this by, for example, considering the results of studies like Searchinger et al., 2015 ("High carbon and biodiversity costs from converting Africa's wet savannahs to cropland" in Nature Climate Change). In addition, converting land has other costs, e.g. loss of biodiversity that go largely unrecognized in this version of the manuscript.

Authors: The authors agree that this is a very important point. However we choose not to account for emissions which will be created for any interventions which are sug-

gested by our study. There are several reasons for this. Firstly, we focus on the mitigation of emissions from forests, and accounting these emissions. Secondly, we don't propose specific interventions, only consider if a suite of possible interventions would be feasible. This is the case for both interventions which intensify agriculture, and also those involved in utilizing available land. There are a number of possible ways which land can be rehabilitated- depending on the intended use, so it is difficult to consider all the possible options at the scale used in this study. Thirdly, we don't propose a specific location for these interventions, and depending on the selected location, the emissions calculations would differ. Since the authors consider this a very important point, the discussion was adapted to include a discussion on the emissions from the conversion of available land to agriculture in section 4.5.

Reviewer:

Specific Comments:

Abstract, final sentence: Can the authors offer a more specific recommendation or put the issue in context by bringing some information that is in the body of the study up to the abstract? For example, are the forestry and agricultural sectors excluded from national mitigation policies?

Authors: the authors accept that this was a vague sentence, and have amended it reflect the intended point, which is that the agriculture sector must be included in decisions on mitigating forest emissions (which are typically confined to the forest and climate change relevant government agencies) and vice versa. National targets for mitigation that do not consider both sectors at the same time will be difficult to implement at sub-national level, where land use planning considers forest and agriculture together.

Reviewer: I understand that the authors want to provide national-level estimates, but the presentation and use of a national yield gap value seems quite uninformative. I suggest the authors provide some information of the range in this value since sub-national

yield and yield gap data are available, and since yield gaps can vary considerably within a country.

Authors: This is indeed a valid point, and the authors will provide the mean and standard deviation yield gap for each country for the three cereal crops in a table in the supplementary materials. However all the variables can vary within and across countries (including deforestation itself), so we choose not to go into in-country variability in the analysis. The aim of the paper is to look at a between-country analysis to identify potential for mitigation, so for this an average country yield gap is informative. It is of course true that the detail is lost, but this should be considered at the project/implementation level (which is mentioned in the discussion).

Reviewer: Page 5439, Lines 22-24: I found this sentence confusing. Authors: this will be rewritten as follows.

"It is possible that synergies occur between closing the yield gap and utilizing available land that can provide benefits when both mitigation approaches are implemented within the same country. However, in this study we assume there is potential to mitigate agriculture-driven deforestation when either one of the two approaches is feasible, and we do not consider any mitigation benefits in countries with potential for both approaches."

Reviewer: Page 5440, Lines 3-5: I don't quite understand what you're trying to say here about your use of thresholds. Authors: this will be rewritten as follows:

"Countries were divided into three groups using each data source, and groups were defined by dividing the data at the 1/3rd and 2/3rd percentiles. Percentiles were calculated using all the countries with available data for that data source within the tropics (Table 1)."

Reviewer: Pages 5442-5443, Lines 23-6: Please restructure this paragraph a bit, it is hard to follow. Authors: this will be rewritten as follows:

"According to the method used in Harris et al. (2012), we calculated emissions by multiplying the area of forest loss by an emissions factor. For the biomass emissions factor, we use the sum of above ground biomass (AGB) and below ground biomass (BGB). We averaged two AGB datasets derived from remote sensing and ground measurements; a tropical dataset (Saatchi et al., 2011) and, a continental dataset (Baccini et al., 2012). Using an average of the two maps is preferred (where there is coverage from both datasets), since the accuracy of both approaches is yet to be determined (Zolkos et al., 2013). Where only one map has data, we used the dataset available. The mean AGB in each country was calculated in forested areas, which were selected using the ESA Global Land Cover map of 2010 developed in Climate Change Initiative (CCI) (ESA, 2013). BGB was calculated from AGB using tree root to shoot ratios equations (Mokany et al., 2006)."

Reviewer: Section 2.2.2 and Table 3: Why did the authors choose 3.5 t/ha as the threshold? I understand that the authors acknowledge this limitation in section 4.4, but it would be more accurate if they changed this value for each country based on the dominant crop, since, for example, the average yield for wheat in a productive area is different than the average yield for corn or rice. Would something like this be feasible for the authors to do/can they do a test to see whether doing this would significantly change their results? Authors: The selection of 3.5 t/ha was based on the thresholds in the dataset of potential crop yields, and was seen as a useful determinant of 'reasonable' yields. A better analysis would involve potential for specific crops, which would include the most suitable crops for each country (datasets are available for rainfed wheat for example). However the authors decided that only selecting certain crops would potentially label areas as being unsuitable, when a crop which is not included would be able to provide high yields. Lack of data is the limiting factor in this case. In addition, since within one country there may be some areas where the dominant crop was not suitable, but other crops would be suitable (for example highland / dryland areas), they also may be misclassified as unsuitable. For these reasons we choose to use a dataset which gives an indication of the potential for a more inclusive system

which is an average yield of 'rainfed agriculture', rather than focussing on a few crops only.

Reviewer: Page 5444, Section 2.4: Please provide more information on the food security assessment and how it relates to mitigation interventions. Otherwise, it is hard to understand how "Food insecurity indicates a risk to livelihoods when implementing mitigation interventions. . ." later on in the paper. Authors: The methods section on risk assessment (section 2.4) has been expanded to explain the components of risk which are being assessed in this case. In addition the introduction has been expanded to explain how livelihoods may be at risk from land-based mitigation approaches, and how food insecurity can be a measure of vulnerability to this risk.

Reviewer: Page 5446, Lines 12-15 and 17-20: It is a bit hard to distinguish the difference in the points you're trying to make with these two sentences. (Similarly, the first sentence of Section 4.1.2 is confusing.) Also, given the issue presented with the Haiti example, perhaps the authors could also present the absolute number of hectares of forest loss in addition to the percentages that are relevant to each respective country? Authors: This is an interesting point. The authors agree that the point is missing in this paragraph, and it has been rewritten (below). The supplementary information shows the absolute area of forest lost to agriculture for each country so this is available for readers.

"The emissions are categorized as follows (Table 1): (1) agriculture-driven deforestation emissions are the main source of the total emissions (>66%); (2) agricultural emissions are the main source (>66%) and (3) agriculture-driven deforestation and agriculture each contribute 33-66% to the total emissions. Those countries where emissions from deforestation are highest include those which have high forest losses due to agricultural expansion, e.g., Zimbabwe 1.35% yr-1 (2548 km2 y-1), and those with a large forest area, e.g., Brazil which loses 0.54% yr-1 (Figs. 4 and 5). Some countries with high agricultural emissions have no deforestation due to agriculture (United Arab Emirates, Djibouti, Eritrea, Mauritania, Niger, Oman, Saudi Arabia). Haiti is an exception

which has a high forest loss due to agriculture (>2% y-1) but most emissions are from the agricultural sector due to the small forest area remaining (1090 km2 in 2000, ~4% of the country area)."

Reviewer: Section 4.3: To be sure, do the authors truly intend to make predictions, or do they intend to make projections with this study? They should double-check their language here. Authors: According to the IPCC (in the context of climate change) "A projection is a potential future evolution of a quantity or set of quantities." This definition matches with the aims of our paper, so as suggested by the reviewer, we choose to change the wording in the manuscript. In order to look at mitigation potential (which is based on avoiding future emissions) we must estimate future emissions.

Reviewer:

Technical comments: Abstract, line 22: I believe you meant ". . .there is a potential to mitigate 1.3 Gt. . .."? Authors: Changed

Reviewer: Abstract, line 25: delete comma. Authors: Deleted Reviewer: Page 5440, Line 17: At this location, as well as all locations in your paper, please be sure to define your acronyms before you use them. Authors: Acronyms defined Reviewer: Page 5444, Section 2.3: Where did the authors acquire the governance data to calculate the index – from World Bank, 2012? It was difficult to tell whether the index algorithm or the index algorithm and the data were acquired from this source. Authors: This has been clarified in the manuscript.

Reviewer: Page 5454, Line 6: I think you meant "within the range of those", and Line 17: I think you're missing a word in this sentence as it is awkward. Authors: The suggested changes have been made.

Reviewer: Page 5455: It should read ". . . the soybean industry's. . ." Authors: Changed

Reviewer: Page 5456: "can be mitigated in those countries in which 33% of emissions

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are produced by agriculture. . ." Authors: Changed

Reviewer: Table 4: The authors should add in some additional lines to delineate the rows from one another, otherwise it is difficult to read. Authors: Changed