Referee Comments

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Title: Mitigation of agriculture-driven deforestation in the tropics: comparing land-sparing options at the national level
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Overall quality of the discussion paper and general comments

This study addresses the importance and potential of forest sparing as a pathway for significant abatement of greenhouse gases (GHG) from land use change. The authors suggested a systematic framework as a common entry point to addressing multiple sources and possible sinks for carbon dioxide (CO2) mostly from the agricultural sector. They hypothesized that improving farming such as agroforestry, climate smart agriculture (CSA), sustainable intensification and similar land management systems will spare forested lands from human pressures and henceforth improve carbon sequestration. The paper is very ambitious in scope and geographical coverage (tropical countries) but the method to achieve the goals quite appropriate. They used mostly secondary data and global databases for their calculations and assessment. Some proxies such as risk was based on food security indices, the least that can be done in assessing social vulnerability and likelihood for relying on natural capital for survival. Similarly baselines forest trends was depicted from conservative approach of past deforestation rate. Overall the methodological choices are very robust but the analysis could be seen as partial as the authors did not consider non-CO2 GHG.

The assumption that improved mitigation is related to good governance systems could be scrutinized more in this study. General governance systems does not always reflect those specific to the agriculture and forest sectors. We are in most cases dealing with polycentric governance systems that sometimes oppose various logics and in many instances competing goals. An example is the often cited in the case of inconsistent policy objectives between agricultural development and forest conservation. Another limit could in the requirements for a full accounting of the carbon equivalent balance. Many authors recognized that full GHG budget is quite difficult to perform in developing countries because of lack of data (Valentini, R. et al. 2014). I fully approve the use of the forest transition curve to support selection of criteria and trend in deforestation but in developing countries there are many possibilities for future tipping points on the natural resources demand as population grows and emerging lifestyle emerges with increased urban population. The emerging demographic and economic situation could lead to more pressures on forest resources but in some instance this could lead to improved forest management with emerging demand for healthy life styles. Finally is important to question how under current and future socio-ecological situation land-sharing with CSA, agroforestry, and sustainable intensification will contribute to overall climate dynamics, and how high subsidies agriculture could lead to more forest sparing but with more ecological and climate footprints. Those aspects could be the subject of another paper.

The focal interest of this paper is on land based mitigation. It is important to recall the readers that Agriculture, Forestry and other Land Uses (AFOLU) a now a specific section within IPCC AR5 (Chapter 11 of WG III). The conclusion of the IPCC assessment shows that AFOLU offers many flexible options (Smith, Bustamante et al. 2014) that the other sectors do not have. These options have different abatement rates but also different costs. It is important to address the issue of trade-offs amid strategic land based mitigation option but also between those and other aspects of sustainable livelihood and development needs. The authors confirmed that agriculture is the main driver of deforestation in tropical area and yet one of the biggest emission sources. The solution for mitigation should be mostly in agriculture not only emission related to deforestation but also emission nested to agriculture systems themselves and food nets. The paper highlighted that land-sparing interventions can potentially be implemented under REDD+ to mitigate the land related emissions. I am not sure if REDD+ is the "silver bullet" solution for reducing GHG, rather additional efforts in non-forested zones through improvement of tree cover, mostly in farming lands could be central to the global solution for land based mitigation strategies. The challenge in developing countries is to meet GHG reduction needs—in the context of Intended Nationally Determined Contributions (INDCs)—without sacrificing food security or natural ecosystems, a challenge called agricultural intensification. Exploring such sustainable intensification pathways should lead us beyond REDD+ that emulates more the countries with dense forest cover. This argument appears in water marks in the paper when the authors stated that deforestation rate as compared to forest cover is higher in non-forested countries (e.g. authors cited Togo, Zimbabwe). Why then too much focus on dense forest countries? (Mbow, C. et al. 2012, Mbow 2014).

The fundamental and technical challenge is how to implement intensification in existing farming lands to avoid net positive emissions including those related to deforestation and low ecological footprint. How to achieve negative emissions through land management systems? Knowing that high inputs and energy intensive agriculture will lead to more emissions (Smith, Haberl et al. 2013).

The merit of this paper not only on the research insights (potential for reducing GHG emission from improved land use) but also on how to close the yield gap. I would wish to add some discussion points on what non-forest lands are used for in developing countries. Not all lands need to be used for agriculture. Some are spared for ecosystem services, and many for grazing. The potential farming lands issue reminds the assumption made by FAO that Africa is among the continent where existing land suitable for agriculture is among the highest. That was an open gate for land grabbing rather than improving agriculture for and limiting deforestation (Mbow and C 2010).

The paper is very rich in content, well organized and quite inspiring for solution oriented climate decisions. The general observations above is simply to contribute to the debate and highlight the bold value of this paper and why it needs to be read. In few details below I raise some minor aspects that could help orient future thinking or even improve the next paper of this wonderful group.

Scientific questions and specific comments

Specific questions arise when reading the paper. One is the perpetual quiz of emission factor. While we know how many 1 kg of carbon will be released by 1 kg of wood, the oxidation processes leading to carbon emission are very diverse and difficult to assess in a GHG budgeting effort. For instance, fires related emission is difficult to estimate because of varying emission factors depending to burning completeness, the fuel models in presence and the fuel moisture during combustion. If we had a good database of emission factors, knowing area affected by deforestation in exact terms is impossible because of method discrepancies and land cover definitional implications.

In this study as in most similar ones, there is not accounting of carbon sequestration through improvement of tree cover in farming lands is important (recovery areas). Maintenance of forest can help avoid emission from deforestation but will not increase substantially carbon sequestration. Trees and soil carbon sequestration can be increased through promotion of trees outside forests.

Another question is what do we do about “non-regret” options such as national parks and protected forest that spare emission from agricultural encroachments with or without REDD+? REDD+ is not fully addressing agriculture even if that sector explain the great deal of deforestation. There is a paradox that makes agricultural intensification—a way for reduced deforestation—as non-REDD+ strategy. CSA is a good mitigation option if implemented well but cannot be a REDD+ branded activity. Agroforestry can be a good mitigation option but up to now there is now REDD+ project based on agroforestry….? Reducing emissions from land use require more inclusion of such practices. A good recommendation is to include land sparing in REDD+ but not at the expense of food security.

On the technical side, methods for GHG accounting differ in precision and level of disaggregation of various components and process of carbon budget. Current scientific knowledge shows various disaggregation approaches based on land use/cover types from fine scales (Brink, A.B. et al. 2009) to global biomes based carbon accounting (Quéré, C. et al. 2012). The complexity of the carbon cycle in particular in Africa requires in situ data and up-scaling of these data at regional scale. Until methods and data are improved it will be very hard to accurately (big uncertainties) know when a country has a high potential for mitigation?

Technical corrections

The authors use remote sensing based forest-cover change data from Hansen or FRA RSS to derive a ratio of net forest change to forest loss “Net:Loss”, and use this factor for estimating gross forest loss from the FAO FRA data. Hansen Data I believe do not use the exact forest definition as FAO did. Also the data work best in pure forest cover biomes. In non-forested lands with trees Hansen maps does not work well (e.g. open savanna or pasture lands). FRA RSS was based on tiles of Landsat data with regular intervals (1 degree interval, 2055 tiles for Africa, 1230 tiles Latin America + Caribbean and 741 tiles South and Southeast Asia). The Sample size is 20 km x 20 km. Then land cover maps and land use maps were based on e-cognition clustering (multi bands, multi years) of small spectral classes using expert knowledge. Regional workshops for validation have been performed to finalize the land and land cover products. The challenge of FRA-2010 data is the status of LANDSAT acquisition under humid forest with a lot of cloud cover that prevent obtaining cloud free data. A big deal of land use emission come from these area where few optical images can be achieved because of “permanent cloud cover” (Roy, P. et al. 2010). The minimum mapping unit of 5 ha, while most land use process happen at small holders plots below the acre in size.

For risk assessment the authors used food security index. Risk is related to 3 pillars: hazard (climate, economic), the vulnerability (poverty, food security) and exposure (how many people, infrastructure etc.). Here only one dimension of risk is taken in relation to food security. I am a bit worrying about the assumption of risk in the paper.

A part from the general and specific comments made on this paper, I believe the article needed to be written to clarify many issues related to the performance of land based mitigation and context specific feasibility of such options. I was delighted to be appointed as a commentator and well open for subsequent discussions on the issues raised in this short review.

References

Brink, A.B., Eva, H.D. (2009). "Monitoring 25 years of land cover change dynamics in Africa: A sample based remote sensing approach." Applied Geography 29: 501-512.

Mbow, C. (2010). Africa's risky gamble. Global Change, IGBP Secretariat, number 75 of June 2010. 75: 20-23.

Mbow, C., Skole, D., Dieng, M., Justice, C., Kwesha, D., Mane, L., E. Gamri, M., V. Vordzogbe, V., Virji and H. (2012). Challenges and Prospects for REDD+ in Africa: Desk Review Of REDD+ Implementation in Africa. , GLP-IPO, Copenhagen.

Mbow, C. (2014). "Examining the deforestation paradox for climate change mitigation in Africa." Opinion http://cdkn.org/2014/09/examining-deforestation-mitigation-in-africa/ 2015.

Quéré, L., C., Andres, R. J., Boden, T., Conway, T., Houghton, R. A., House, J. I., Marland, G., Peters, G. P., v. d. Werf, G., Ahlström, A., Andrew, R. M., Bopp, L., Canadell, J. G., Ciais, P., Doney, S. C., Enright, C., Friedlingstein, P., Huntingford, C., Jain, A. K., Jourdain, C., Kato, E., Keeling, R. F., K. Goldewijk, K., Levis, S., Levy, P., Lomas, M., Poulter, B., Raupach, M. R., Schwinger, J., Sitch, S., Stocker, B. D., Viovy, N., Zaehle, S., Zeng, N. (2012). "The global carbon budget 1959–2011." Earth System Science Data Discussions 5(2): 1107-1157.

Roy, D. P., Ju, J., Mbow, C, Frost, P, Loveland, T. (2010). "Accessing free Landsat data via the Internet: Africa's challenge'." Remote Sensing Letters 1(2): 111-117.

Smith, P., M. Bustamante, H. Ahammad, H. Clark, H. Dong, E. A. Elsiddig, H. Haberl, R. Harper, J. House, M. Jafari, O. Masera, C. Mbow, N. H. Ravindranath, C. W. Rice, C. R. Abad, A. Romanovskaya, F. Sperling and Tubiello F. (2014). Agriculture, Forestry and Other Land Use (AFOLU). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Edenhofer, O., R. Pichs-Madruga et al. Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press. WG-III: 811-922.

Smith, P., H. Haberl, A. Popp, K. Erb, C. Lauk, R. Harper, F. Tubiello, A. d. S. Pinto, M. Jafari, S. Sohi, O. Masera, H. Böttcher, G. Berndes, M. Bustamante, H. Ahammad, H. Clark, H. Dong, E. A. Elsiddig, C. Mbow, N. H. Ravindranath, C. W. Rice, C. Robledo-Abad, A. Romanovskaya, F. Sperling, M. Herrero, J. I. House and S. Rose (2013). "How much land based greenhouse gas mitigation can be achieved without compromising food security and environmental goals?" Global Change Biology Review(DOI.10.1111/gcb.12160).

Valentini, R., Arneth, A., Bombelli, A., Castaldi, S., C. Gatti, R., Chevallier, F., Ciais, P., Grieco, E., Hartmann, J., Henry, M., Houghton, R. A., Jung, M., Kutsch, W. L., Malhi, Y., Mayorga, E., Merbold, L., Murray-Tortarolo, G., Papale, D., Peylin, P., Poulter, B., Raymond, P. A., Santini, M., Sitch, S., V. Laurin, G., v. d. Werf, G. R., Williams, C. A., Scholes and R. J. (2014). "A full greenhouse gases budget of Africa: synthesis, uncertainties, and vulnerabilities." Biogeosciences 11(2): 381-407.