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Discussions

Interactive comment on "Simulating sustained yield harvesting adaptive to future climate change" *by* Rasoul Yousefpour et al.

Anonymous Referee #1

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The authors use a state-of-the-art Earth System Model (ESM) "JSBACH" to show that a revised harvest schedule in order to keep the forest carbon pools constant under climatic change will lead to harvest amounts twice to four times larger than those scheduled under standard harvesting rules, with the latter being based on Integrated Assessment Models. The net mitigation effects over the 21st century would then be much higher than under standard assumptions.

This paper is well written and illustrated and the results stress the importance of forest management, but there exists concern about the assumptions made to generate these results. The assumptions appear in part too artificial, so that the conclusions made are possibly not all well justified.

General comments:

1) Harvesting always the timber growth (increment) is a famous traditional forest management rule, which foresters have tried to apply already for more than one century, but which is hardly possible to be achieved. For example, following an empirically/iteratively based form of forest planning, the so called "Kontrollmethode" has been developed for forest management already at the end of the 19th century by de Liocourt (France) and Biolley (Switzerland). Implementation of such traditional harvesting rule into a state-of-the-art ESM has some originality, although it appears rather unrealistic that the assumption to apply this rule may ever be a realistic guide for real world forest management. This would also raise doubts about its usefulness for aggregated global projections.

In forest management the timber increment may only be measured post hoc and past increments can hardly be used to predict future timber increments. The historical and future timber increment depend both much on the actual forest structure, which is continuously changing. But this is only one limitation for the application of the modelled harvesting rule. Even more important is the in this study disregarded accessibility of the standing timber volumes in the world's forets. It may be totally uneconomic to harvest on steep mountain slopes or to carry out sustainable harvest (without deforestation) in hardly accessible tropical regions. Disregarding the probability with which a harvest will actually occur at a certain place will always lead to a great overestimation of the actually possible harvest. Such overestimation appears to be the case with the current paper as well. In conclusion, a better justification of the adopted harvesting rule and a more critical discussion of the results would be desirable.

2) One could consider it also as a limitation that the area occupied by a specific plant functional type have been kept constant, which means that an important element of dynamic vegetation modelling has been excluded. The assumption of a constant forest area over the next 100 years alone is very strong, meaning that land-use/cover change is ignoredover such long period. Furthermore, one of the most important tasks of forest management is to plan meaningful change of the forest composition, for example to

adapt to climate change. As mentioned already the structure of the harvests (size of harvested timber, tree species) would be important for the structure of the remaining timber volume. This would also have an impact on the timber growth. It is still a bit unclear how these complexities have been addressed. Alternatives to the harvesting algorithms applied in this paper should be discussed, or even better applied.

3) In addition, the notion that socio-economic rules to decide when and how much timber to harvest would always disregard actual environmental conditions is not fully valid. Often, the achieved timber size (Europe) or an economic criterion (international perspective), such as the maximum soil expectation value, are criteria to decide when to harvest. These criteria depend on the environmental conditions and could alternatively have been used to carry out predictions on timber harvests or to provide scenarios on a more realistic basis.

4) A central outcome of the submitted study is a much increased timber harvest particularly in the tropical forest biome (Figure 2). This result could be interpreted with more care. The tropical biome still comprises vast area of more or less natural forest, where NPP may actually be high. But NPP is not equal to commercial timber harvest and harvesting up to 25 - 30 kg C per square meter (2006-2100) in these forests would certainly destroy these ecosystems, with their particularly rich biodiversity. A harvest of 25 kg C per square meter would mean harvesting in the order of 1000 cubic meters per hectare over 94 years (or around 10 cubic meters per ha per year). This rough estimation implies 50% C content in dry woody biomass and an average timber density of 500 kg per cubic meter. Such harvest would be detrimental, as these natural ecosystems can often provide not much more than 0.5 cubic meter commercial harvest per hectare per year on a sustainable basis.

5) It appears that sustainable yield harvesting mainly reflects the NPP of the forests considered, because the size of the NPP appears to be harvested. The distribution of this NPP (see Figure 2) could be an interesting issue as well for a revised paper.

Should the harvesting aspect still be the main focus of an improved manuscript, one could consider the following recommendations:

More detailed issues:

1) The assumed lifetimes for wood products appear very high. They should be better justified and compared with those assumed for other studies, for example by Härtl et al. (2017) in Mitigation and Adaptation Strategies for Global Change. One could mention that there is still very large uncertainty concerning these values.

2) The sustainable yield scenario should be critically discussed considering the issues mentioned above. Moreover, some constraints could be considered. For example could the harvest in protected areas and in inaccessible forest areas be significantly reduced or even set to zero. For the purpose of a better prediction of the possible harvest, one could refer to the recent works by Luciana de Avila, e.g. “Recruitment, growth and recovery of commercial tree species over 30 years following logging and thinning in a tropical rain forest“, which recently appeared in Forest Ecology and Management.

3) The discussion of discounting C over time is unclear. Also, more recent references could be included, such as Johnston and van Kooten (2015) "Back to the past: Burning wood to save the globe" published in Ecological Economics.

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