Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
https://doi.org/10.5194/gmd-2021-76-RC1, 2021

Comment on gmd-2021-76

Pekka Lauri (Referee)

Referee comment on "Estimating global land system impacts of timber plantations using MAgPIE 4.3.5" by Abhijeet Mishra et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-76-RC1, 2021

Review report "Estimating global land system impacts of timber plantations using MAgPIE 4.3.2 "

The manuscript presents an updated version of MAgPIE forest sector module, which includes forest age-class dynamics and two types of managed forests (timber plantations, natural forests). Usually large-scale land-use models such as MAgPIE do not include forest age-class dynamics, so this is an important contribution in the field and deserves to be published. However, a proper modelling of forest management requires that forest-owners anticipate the future changes in harvest volumes. MAgPIE is a recursive dynamic model, which means that the model is forced to make some simplifications concerning the future foresight. The manuscript should include more detailed discussion on these simplifications since they seem to have significant impact on the results.

General comments:

1) p12L200-215: The expansion of timber plantation depends on the share of production that comes from plantations (η). This parameter is exogenous and extrapolated from Pöyry (1999). This means that the expansion of plantation is not endogenous in the model, but it is taken as given. According to figure A5, the model assumes that share plantation increases on average from 25% in 2000 to 62.5 % in 2100. This issue should be made clear already in the abstract because it has significant impact on the results. For example, if the share of plantations were endogenous in the model, then an increasing demand for roundwood would increase the share of plantations relative to natural forests in EUR region. But because the share is exogenous this does not happen, and EUR region is not able adapt higher demand by intensifying their forest management (Figure A6).

2) The outcome of the optimal rotation models depends much on interest rates and usually these models include sensitivity analysis relative to different interest rate. To

avoid this complication, the rotation times could be solved by maximizing increment (f'=f(ac)/ac) instead of maximizing NPV (f'(ac)/f(ac)=r). This would also be more reasonable objective for the recursive dynamic model where all other choices are based on recursive optimization instead of intertemporal optimization.

3) Add some discussion about the forest age-class dynamics and optimal rotation models in the introduction. Basically move some material from discussion to introduction. Including forest age-class dynamics in the large-scale land-use model is the main contribution of the study, but this issue is completely ignored in the introduction.

Specific comments:

1) p2L26: According to FAOSTAT global roundwood demand was 3969 Mm3 in 2019 and industrial roundwood 2024 Mm3. Global roundwood demand cannot be 1683 Mm3.

2) p2L26 Add reference or explanation for 33% (560 Mm3) plantation supply -> Pöyry (1999) extrapolation (Figure A5). This it is not data but model outcome.

3) p2L38: Add more relevant references for high roundwood productivity of plantations relative to natural forests than FAO (2013), e.g. IPCC (2006). Also, add some explanation why roundwood productivity is higher in plantations than managed natural forests.

4) p6L124, p6L132, p7L136: Equation should be f '/ f=r.

5) Rotation times for timber plantations in Figure 4 are "interesting", but the question is how reasonable they are. For example, with 30-40 years rotation time in Russia and Europe you get only pulpwood (sawlogs require 60-100 years rotation). Moreover, it is not clear why rotation times are longer in North-America than in Europe and Russia. Is this connected to interest rates or productivity? There is only a small difference in interest rates (Table A2) and there should not be large differences in biomass growth between these regions. Some discussion of this should be added and eventually an update to growth curves, interest rate data and add a minimum diameter constraint for sawlogs.

6) Is rotation time for natural forests determined by the same rule than for timber plantations (equation 1). If yes, then add similar map (Figure 3) for natural forest rotation time. It would be interesting to see the regional difference between timber plantations and natural forests rotation times. If no, then add some justification why natural forest rotation time is chosen differently than in timber plantations. Basically explain also natural forest rotation lengths in chapter 2.3.

7) According to Figure A8 EUR region growing stock decreases close to zero in 2100, which implies that forest management is not sustainable in EUR region. Easy way to avoid this would be to add additional "sustainability" constraint on harvests (harvests ≤ α x increment where α=1 for normal forests, α> 1 for old forests and α < 1 for younger forests). Alternatively, increase the share of plantation in EUR region. Basically take account in extrapolation of η that demand increases in the future. Interesting is also opposite development of growing stock in CHA region. This seems to be connected to the higher share of roundwood production coming from plantation in CHA region (Figure A7). Why cannot EUR region do the same as CHA region and avoid the decrease in growing stock ?