Global forestry emission projections and abatement costs

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Background and research question

Emissions from land use change (LUC) contributed about 3.3 Gt CO_2 (or 9%) to total greenhouse gas (GHG) emissions in 2010 (1,2). This LUC includes emissions from the conversion of forests to other land uses (deforestation) but also CO_2 removals through the establishment of new forests (afforestation). Not included in the balance are emissions and removals from existing forests that contributed in 2000-2007 to a **global net forest sink of 4.4 Gt CO_2** including management of exiting forests (FM), afforestation (AR) and deforestation (D) (3). An important question for an assessment of global climate change mitigation options in the land use sector is how much of these global fluxes can be manipulated and managed through forestry activities and changes of management practices.

How much can forestry emissions be reduced and forest sinks be enhanced?

An active change of forest management change, a reduction of deforestation rates and increased afforestation efforts are likely to impact wood supply and revenues from forestry. Another important question is therefore **at what costs** mitigation potentials in the forestry sector could be realized.

A challenge is to **include indirect effects between single activities** as they compete for a limited land resource and have common drivers (e.g. wood demand). We use IIASA ESM's Global Forestry Model (G4M) to assess the forestry mitigation potential and estimate costs. The model is spatially explicit and compares the NPV of management alternatives.

Results 1: Baseline of global forestry emissions

Global deforestation (D) drops from about 4Gt CO_2 (12 Mha) in 2005 to below 3Gt CO_2 (10 Mha) after 2015 and reaches less than 2 Gt CO_2 (5 Mha) in 2050. Afforestation (AR) rates remain fairly constant (2 Gt CO_2 or 7 Mha).

Although we observe a net area increase of global forest area after 2015 net emissions from deforestation and afforestation are positive until 2045 as the newly afforested areas accumulate carbon rather slowly.

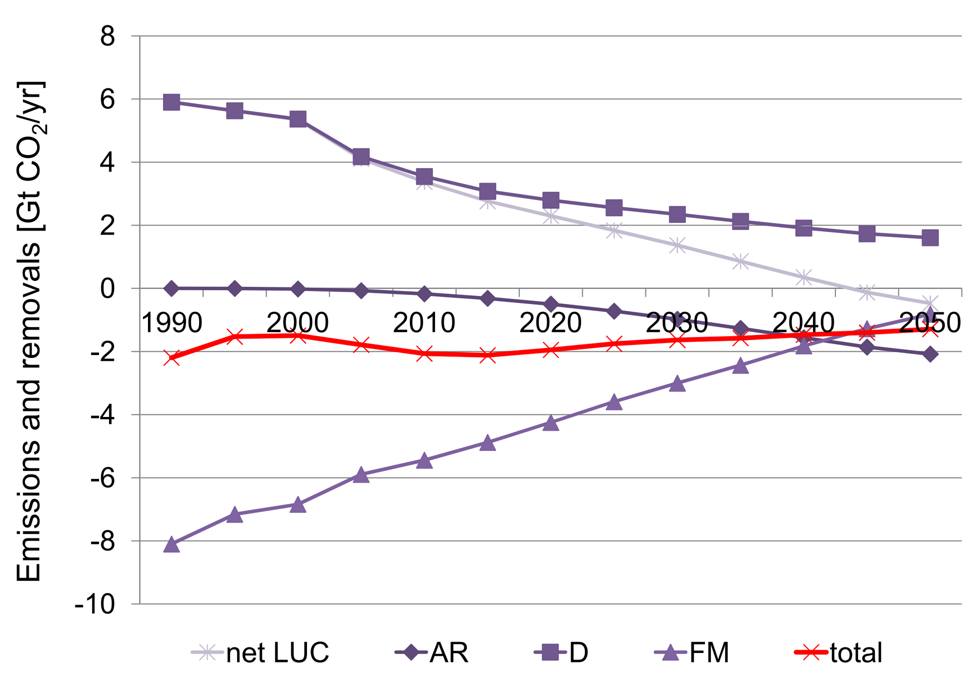
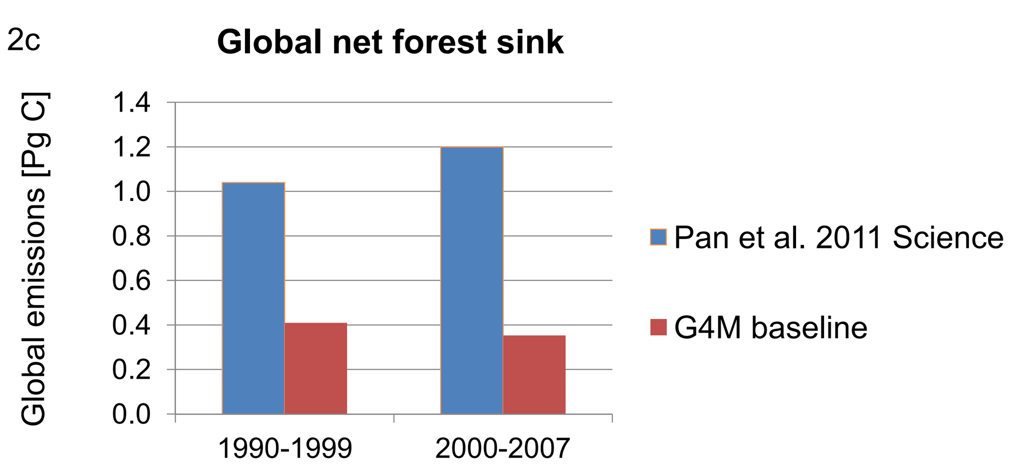


Fig 1. Forest biomass baseline emissions in Gt CO2.

Comparison of baseline to historic estimates

Our results can be compared with historic data (based on inventories) for an overlapping period of 1990-2010. We systematically underestimate the gross forest sink due to the fact that we do not consider additional growth effects (CO_2 fertilization, N deposition, etc.). This leads to a considerable underestimation of the net forest sink (Figure 2c). But uncertainties of the historic estimate are high (about 70%).



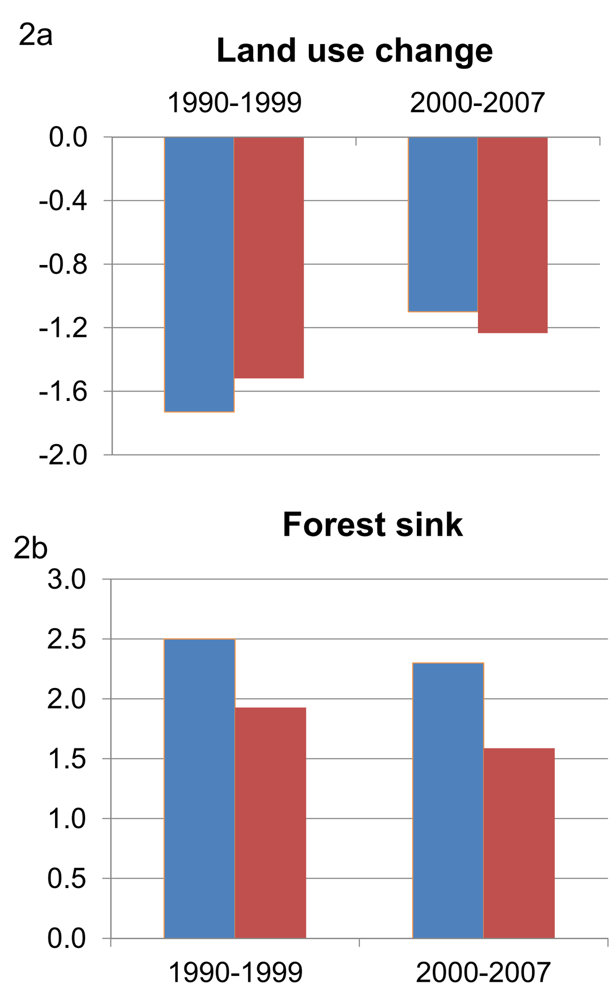


Fig 2a-c. Comparison of baseline to historic estimates.

Map of baseline deforestation in 2030

The map in Figure 5 shows the baseline deforestation in 2030. The spatial dynamics of where deforestation takes place are model internally driven by land productivity (NPV of forestry compared to NPV of agriculture) and past deforestation rates in that grid cell. To improve the geographical accuracy of the projection we plan to include maps of infrastructure projects in the future and to calibrate the model to historic maps of forest area change from satellite products that have recently become available.

References

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Results 2: Effect of integrated abatement cost curves in Annex I countries

Avoided deforestation (D) leads to more harvest in existing forests (FM). These additional emissions (compared to baseline) need to be included.

While the AR potential is negligible in Annex 1 countries because of a rather high baseline and a time lag until the new forests start to grow faster, there is more potential for FM and avoided D (cf Fig. 3b).

Competition for land and the shift of wood supply from deforestation to managed forests reduce the potential.

The ***integrated*** mitigation potential for single activities (here D) is smaller (cf Fig. 3a and b) since negative impacts on other activities (here FM) are accounted for.

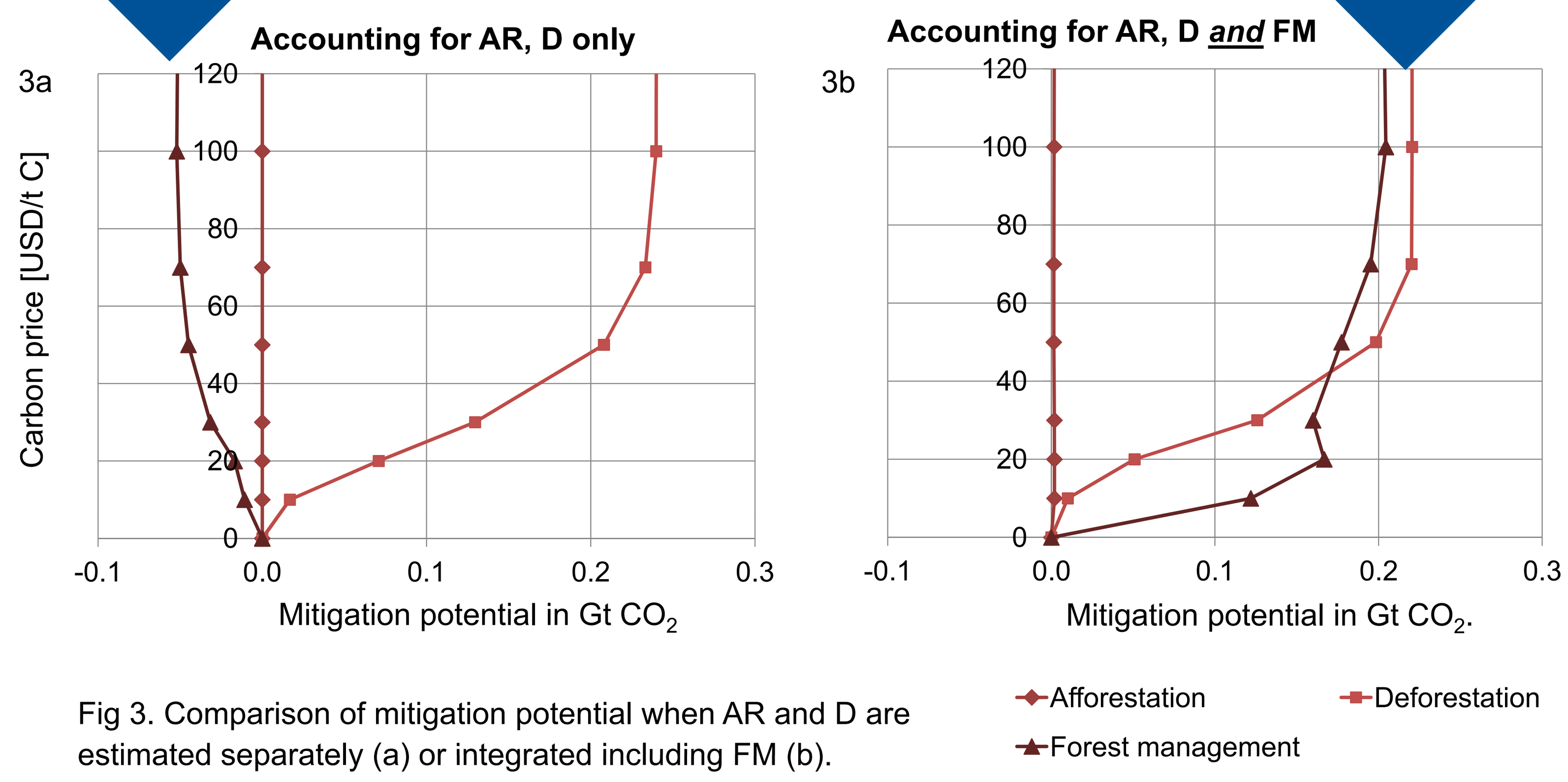


Fig 3. Comparison of mitigation potential when AR and D are estimated separately (a) or integrated including FM (b).

Conclusions

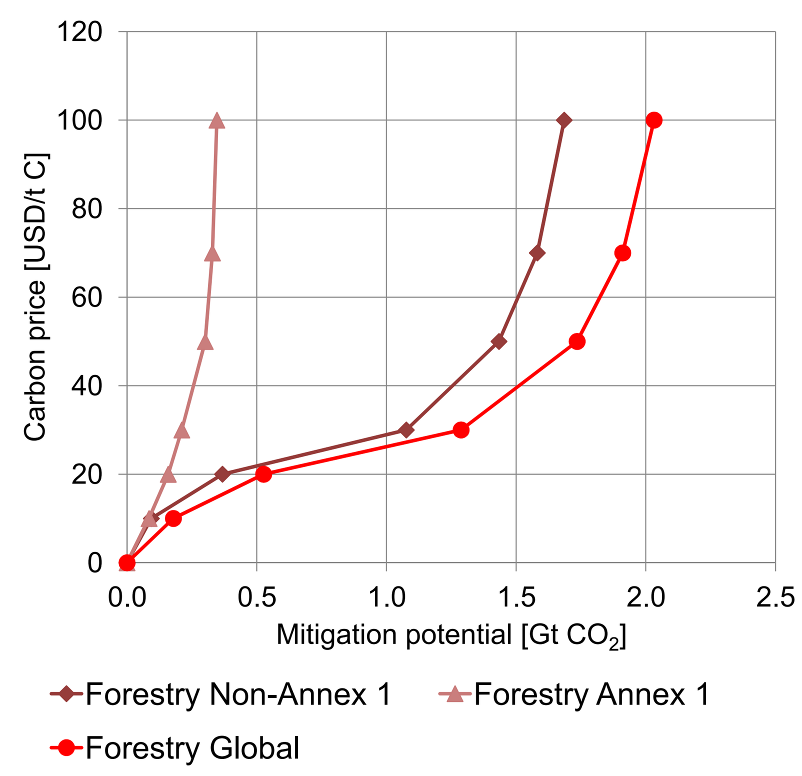
- The forestry climate change mitigation potential of single activities (enhanced afforestation, avoided deforestation, improved management) are not independent of each other. E.g. more avoided deforestation reduces potential for afforestation and increases also pressure on remaining forests with implications for the C balance.
- Many potential estimates disregard such indirect effects and dependencies and are therefore too high. We present integrated mitigation potentials and cost curves that account for competition for land and other common drivers.
- There is a need for taking an integrated view on mitigation potentials to account for leakage across activities, sectors, and countries.
- Risks that further lower the realizable potential are policy inefficiency, additional costs (monitoring, transaction), and natural disturbances that have not been taken into account.

Results 3: Mitigation potential and costs of forestry activities

Figure 4 shows the additional CO_2 storage in comparison to the baseline at different carbon price levels. The carbon price leads to a change in the behavior of land owners. They increase afforestation, avoid deforestation and improve forest management.

Annex 1 countries have naturally a lower potential because of the smaller area and lower deforestation rates in the baseline that could potentially be avoided, but also because of higher costs. Large potentials in Non-Annex 1 countries can only be realized at higher C prices (above 25 USD per tC).

Fig 4. Cost curve for mitigation measures in the forestry sector for different groups of countries.



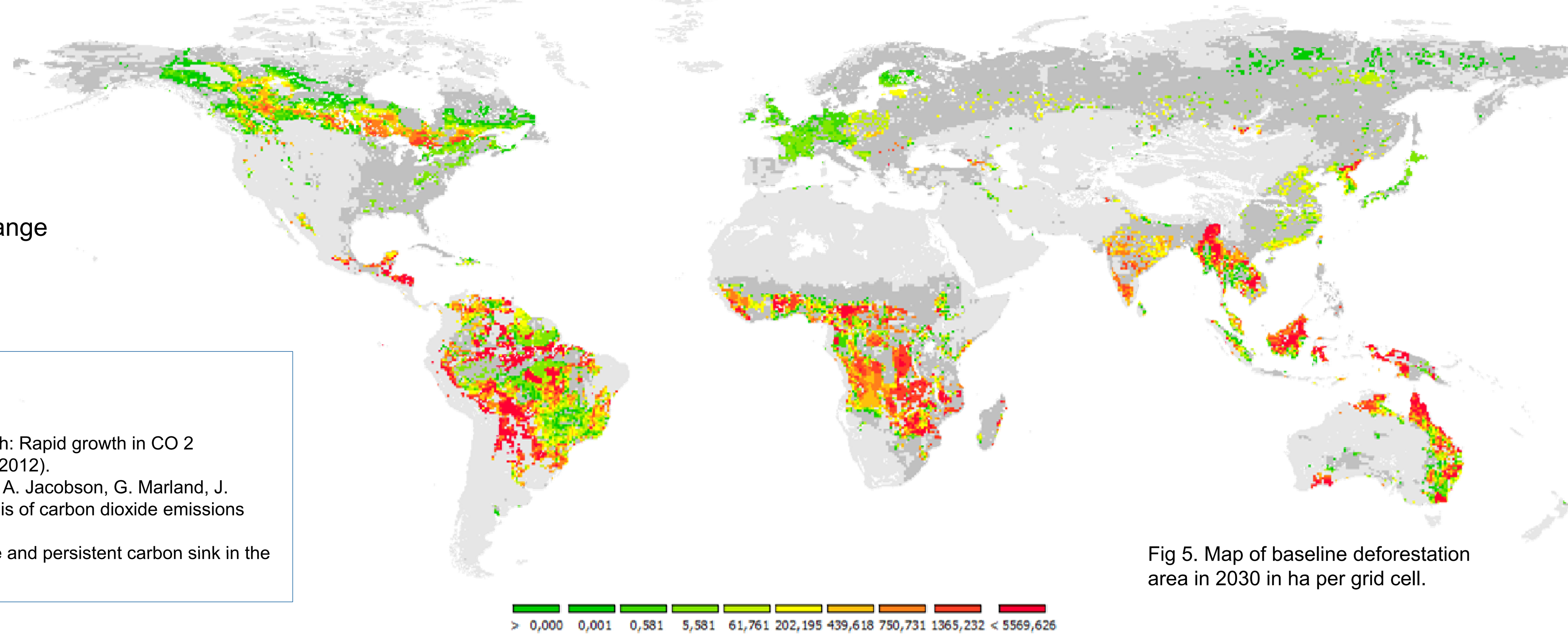


Fig 5. Map of baseline deforestation area in 2030 in ha per grid cell.