

Mitigation potential of forest management and wood products use

Simulation study for intensive monitoring plots of Brandenburg, Germany

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Global Carbon Budget







Which forest management offers the highest CO₂ mitigation potential?

Increasing carbon sequestration in forest ecosystems

or

Increasing harvest to intensify the usage of wood





Assessment of two forest management strategies on the CO₂ mitigation potential taking into account

- Carbon stocks in ecosystems (vegetation, litter, CWD, soil)
- Carbon stocks in wood products
 (paper + paperboards, furniture, construction)
- Substitution effects of wood products use (energy and material substitution)

Wood products

- wood products model (CASTLE_WPM)
- C stocks and fluxes
- substitution effects

Forest growth and C budget of ecosystems

physiology-based model (Biome-BGC vers. ZALF)

Forest management

Model approach

thinning scenarios









Investigated sites in Brandenburg/Germany





7 intensive monitoring plots of ICP Forests Level II

Pine	Beech	
Pinus sylvestris	Fagus sylvatica	
	5 - 10 0 -	
DE1201 DE1202	DE1207	
DE1203 DE1204		
DE1205 DE1206		
DEIZOS DEIZOO		



Management strategies	Yield → increase yield	Business as usual (BAU) → yield table	Storage → increase storage
Management measures			
Rotation period	short Beech 120 yrs., Pine 90 yrs.	intermediate Beech 180 yrs., Pine 120 yrs.	long Beech 240 yrs., Pine 180 yrs.
Thinning intensity	high (+10%)	intermediate	low (-20%)
Harvest fraction	high (+5%)	intermediate	low (-20%)

Simulation period





Wood Products Model (CASTLE_WPM)





Displacement factors:

(Knauf et al. 2015)

- 1.50 t CO₂-C/t HWP-C for material substitution
- 0.67 t CO₂-C/t HWP-C for energy substitution

Brunet-Navarro et al. 2018: Journal of Cleaner Production 170: 137-146

Development of C stocks over one rotation period







Effects of forest management on C stocks of the forestry sector



- Similar results of all sites
- Increasing C stocks under the Storage strategy
- Decreasing C stocks under the Yield strategy
- Mean C fraction of wood products → 6 – 11 %





Mean values of 7 plots

Storage strategy

- Forest ecosystems 1 37 t C ha⁻¹, mainly vegetation
- Wood products ¹ 5 t C ha⁻¹
- Forestry sector 1 32 t C ha⁻¹

Yield strategy

- Forest ecosystems ↓ 32 t C ha⁻¹, mainly vegetation
- Wood products \uparrow 2 t C ha⁻¹
- Forestry sector \downarrow 31 t C ha⁻¹





Effects of forest management on substitution effects due to wood products use



Mean values of 7 plots



Storage strategy

- Wood harvest \downarrow 0.49 t C ha⁻¹ a⁻¹
- Substitution effects ↓ 0.55 t C ha⁻¹ a⁻¹

Yield strategy

- Wood harvest 10.15 t C ha⁻¹ a⁻¹
- Substitution effects
- 1 0.15 t C ha⁻¹ a⁻¹ 1 0.17 t C ha⁻¹ a⁻¹





Approach: Compare C stocks in the forestry sector **at steady state** with the **cumulative substitution effects** as **difference to BAU**.

Storage strategy

The advantage of higher C stocks in the forestry sector compared to BAU (31.7 t C ha^{-1}) is overcompensated by lower substitution effects (-0.553 t C $ha^{-1}a^{-1}$) after 57 years.

Yield strategy

The disadvantage of lower C stocks in forest ecosystems and wood products compared to BAU (-30.7 t C ha^{-1}) is overcompensated by higher substitution effects (0.173 t C $ha^{-1} a^{-1}$) after 177 years.



- The forest management strategy "storage" provides the highest C sequestration potential in the forestry sector, the "yield" strategy the lowest.
- The increase of C stocks in ecosystems in the storage strategy is partly compensated by lower C stocks in wood products.
- The storage strategy shows higher mitigation potential due to carbon storage, but decreasing cumulative substitution effect.
- The yield strategy shows lower mitigation potential due to carbon storage, but increasing cumulative substitution effect.



- Forest management can contribute to mitigate climate change.
- Substitution effects of wood products use have to be considered when assessing forest management effects.
- The advantage of the storage strategy compared to BAU lasts only for half of a rotation period until overcompensated by the disadvantage of lower substitution effects.
- The approach combining potential C stocks at steady state with rates of substitution effects is an alternative measure to assess mitigation effects of forest management.





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