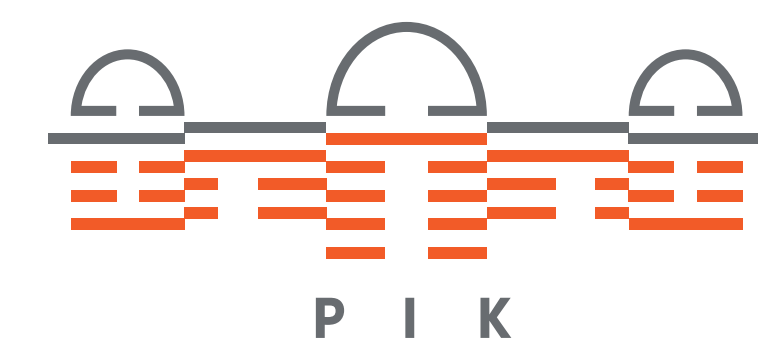


Exploring the carbon dynamics of the standing stock-harvest trade-off in the German forest

Thirza W. van Laar, Mats Nieberg, Christopher P.O. Reyer

Potsdam Institute for Climate Impact Research - member of the Leibniz Association



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Introduction

- The carbon sequestration that is required for climate mitigation can happen either in the standing stock or in harvested wood products.
- The interaction between these two carbon sinks is generally considered a trade-off (Gutsch et al. 2018), although some studies have shown that synergies are possible as well (Biber et al. 2020, Seidl et al. 2007).
- To explore the carbon dynamics of the German forest we developed 16 management scenarios (see also the poster of Mats Nieberg) that we simulate using the process-based forest model 4C (Lasch-Born et al. 2020), driven by different future climate scenarios.
- In the analysis we focus on both short- (one year) and long-term effects (total simulation period, 88 years) of management on carbon sequestration.

4C simulations

Scenario combinations:

GCM x SSP x Conversion x Management

- GFDL-ESM4
- IPSL-CM6A-LR
- MPI-ESM1-2HR
- MRI-ESM2-O
- UKESM1-O-LL
- SSP126
- SSP245
- SSP370
- SSP585
- Unconverted
- Slow (baseline, 22,000 ha/yr)
- Fast (95,000 ha/yr)
- Baseline (WEHAM)
- Natural
- Intensified
- Industrial
- Quality
- No management

Management scenarios:



	Natural	Baseline	Quality	Intensified	Industrial
Basal area	+20%	Basis	-20%	-20%	-20%
Rotation period	+20%	Basis	-10%	-20%	-40%

Further details:

- Initialization with BWI3 (2012)
- Management is based on basal area, so more favourable growing conditions lead to more harvest
- Tree species for conversion based on EUTrees4F dataset (Mauri et al. 2022)
- Conversion speed based on Bolte et al. (2021)
- All results are averaged over Germany and all GCMs
- Here we only analyse SSP126 and SSP585

Methodology

Short-term interaction:

- Take the derivative for every timestep and compare its' sign between ecosystem carbon and harvest:
 - Both positive or negative: synergy
 - One positive and one negative: trade-off
- Calculate the proportion of years with a trade-off

Long-term interaction:

- Assume linearity for the whole simulation period
- Perform linear regression
- Determine the slope of the linear relation for both ecosystem carbon and harvest:
 - Both positive or negative: synergy
 - One positive and one negative: trade-off

Results

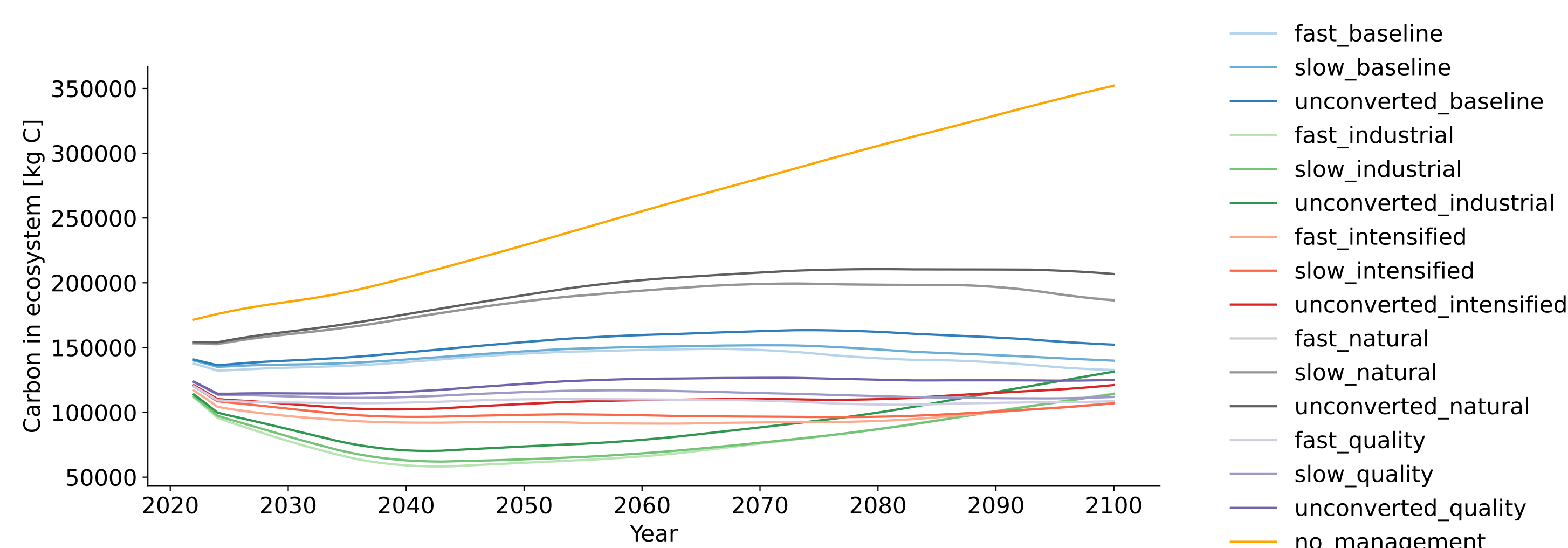


Figure 1: 10 year moving average of ecosystem carbon (including soil carbon) for SSP126

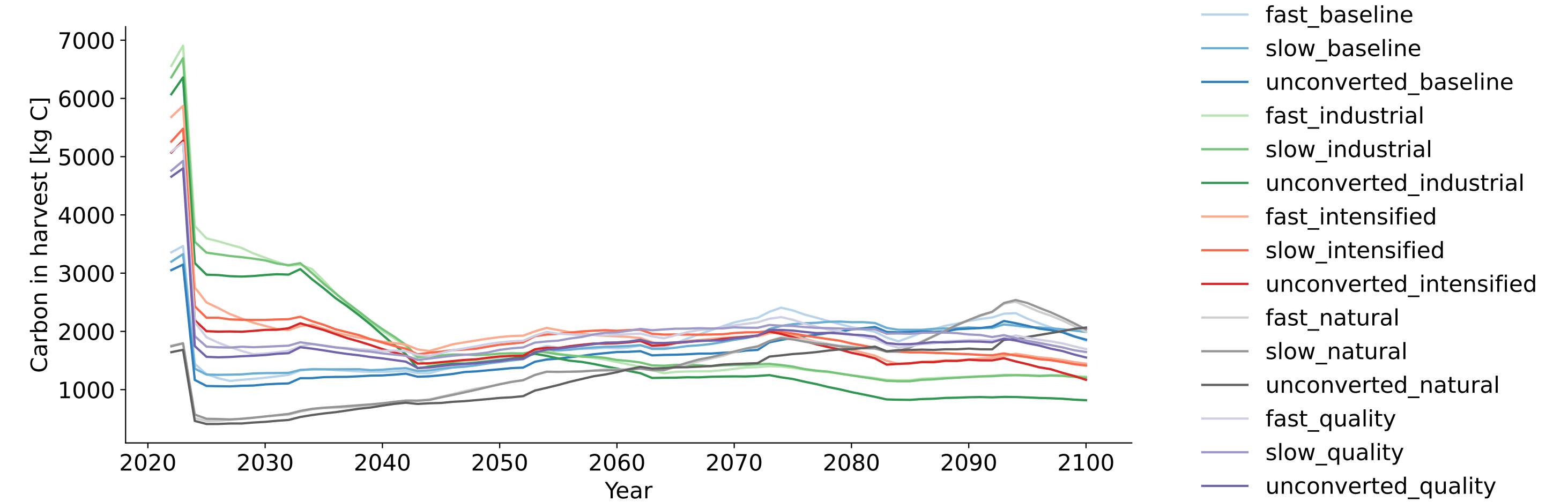


Figure 2: 10 year moving average of carbon in harvest for SSP126

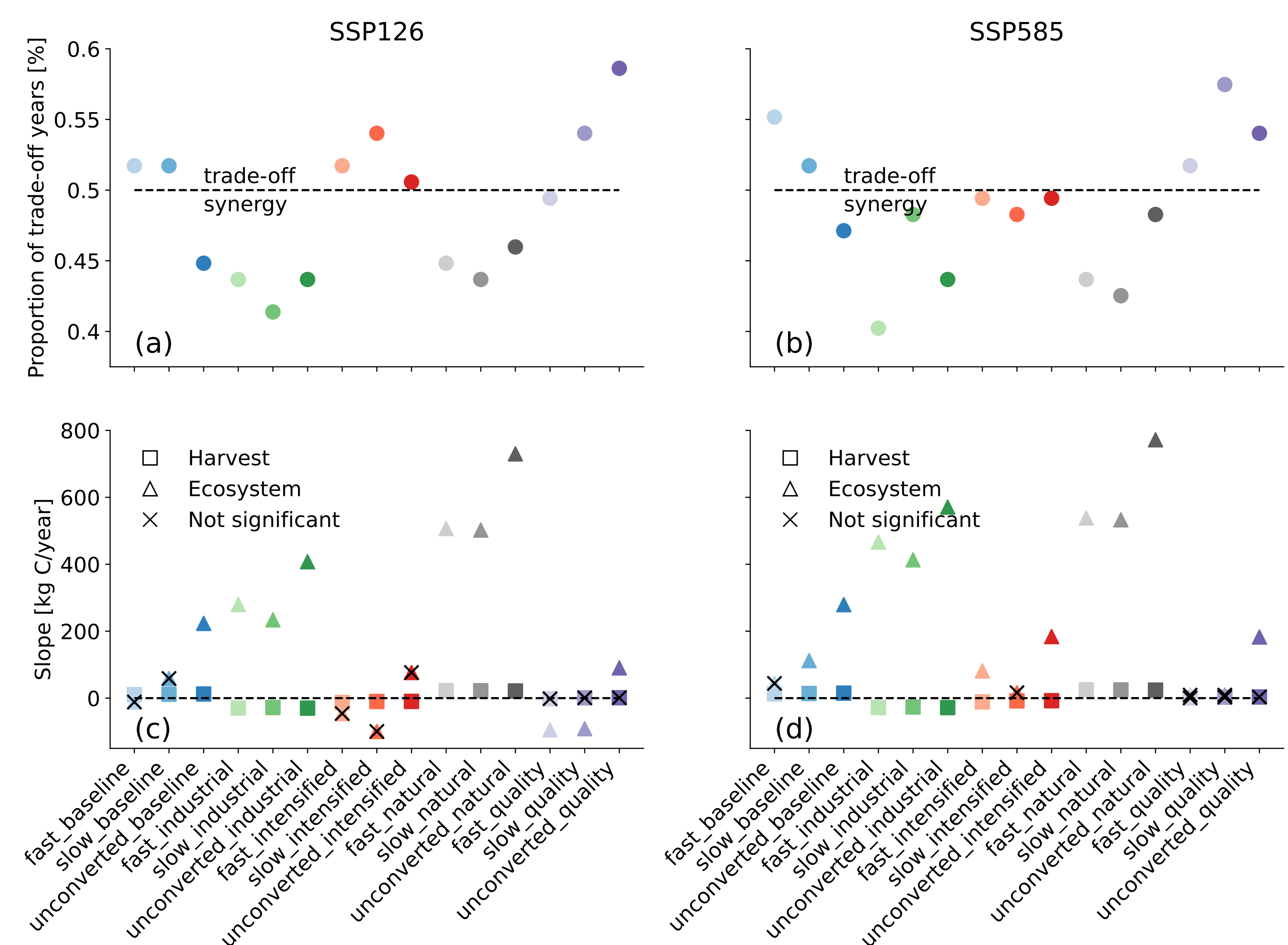


Figure 3: Upper row: proportion of years where the derivatives of carbon in the ecosystem and carbon in harvest have a different sign. Lower row: slope of the linear regression for carbon in the ecosystem (triangle) and carbon in harvest (square). A slope not significantly different than 0 is indicated with a cross. The first two simulation years are ignored for the calculation of the slope due to a transition period in which there is a backlog of too large diameters.

Discussion

Results short-term analysis:

All scenarios have values close to 0.5, so no clear trade-off or synergy. When taking 50% as reference, the intensified scenarios switch from showing predominantly a trade-off to showing a synergy when comparing SSP126 with SSP585.

Results long-term analysis:

Only the industrial scenarios show a clear trade-off, for both SSP126 and SSP585. Natural management shows a synergy for both analysed climate scenarios.

Comparing short- and long-term analysis:

The industrial scenarios show a synergy on a short time-scale, but a trade-off on a long timescale. Natural management shows a synergy on both the short and the long timescale.

Acknowledgements

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