

Differences in forest carbon stock and timber supply between management options under changing climate

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Introduction and objectives

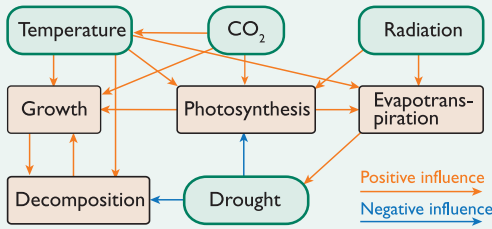


Fig. 1. Changes in the climate will affect both primary production and decomposition of organic matter. Understanding of interaction between tree growth and soil processes is needed for projections of forest development in climate change scenarios.

Objective of this study was to investigate the responses of tree growth and forest carbon sequestration to changes in temperature and precipitation under different management plans, i.e.,

- i thinnings from below and final harvest according to current recommendations,
- ii delayed thinnings from above with higher removals and early harvest (economical optimum)⁵,
- iii natural development without management.

We simulated these management plans under both current and changing climate (A2 scenario: temperature +3 °C, precipitation +10%).

Methods

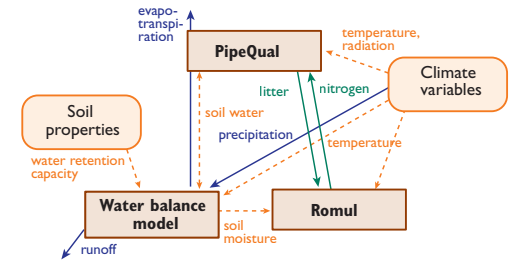


Fig. 2. The simulations are based on the interaction of three submodels: process-based stand growth model (PipeQual)^{1,2}, soil water balance model³ and soil decomposition model (ROMUL)⁴. The three models interact in multiple ways. The stand characteristics modify evapotranspiration, which affects soil moisture. Stand development is estimated by the growth model, which also provides organic material for decomposition as litter. The decomposition model calculates N availability, which affects the stand growth. Soil water conditions affect evapotranspiration and the decomposition.

Results

- Soil carbon stock decreases for the first 20-30 years after clear-cutting, when the tree biomass and litter fall from the living trees are low. At the age of 42-years biomass carbon stock reaches the size of soil carbon stock (Figs. 3 and 4).
- Economically optimal thinnings results in a higher biomass carbon stock in the young stands and lower in the older stands than current recommendations. Large removals results in a decreasing trend of soil carbon stock (Fig. 4).
- In warmer climate trees allocate larger proportion of the biomass to the stemwood than

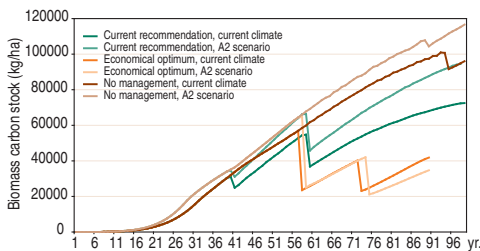


Fig. 3. Biomass carbon stock with different management plans in current and changing climate (A2 scenario).

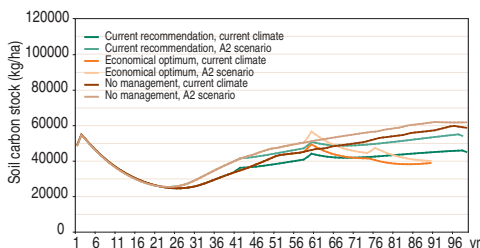


Fig. 4. Soil carbon stock with different management plans in current and changing climate (A2 scenario).

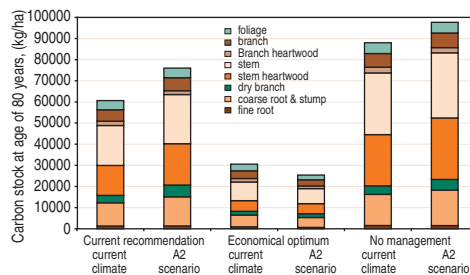


Fig. 5. Stand biomass carbon stock at age of 80 years with different management plans in current and changing climate (A2 scenario).

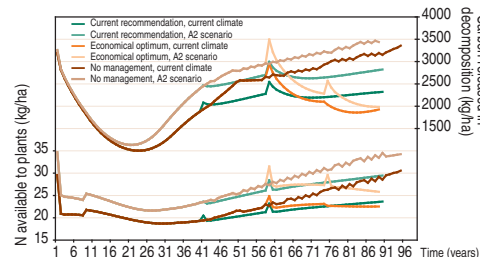


Fig. 7. Simulated carbon release in decomposition (upper part) and the amount of nitrogen available to the plants (lower part) with different management plans in current and changing climate (A2 scenario).

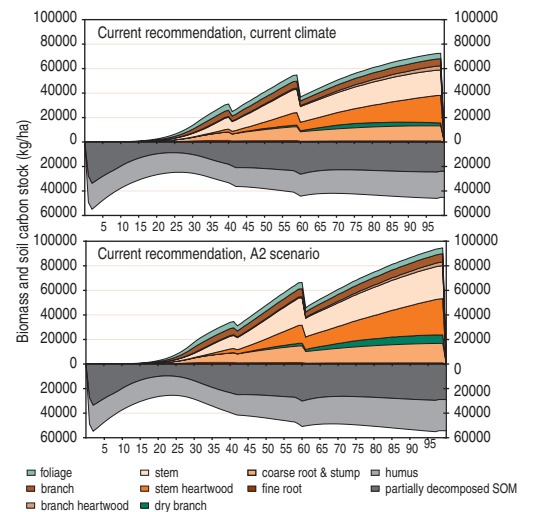


Fig. 6. Carbon stocks of biomass compartments and soil fractions (partially decomposed litter and soil organic matter, and relatively stable humus fraction) in the current (upper panel) and changing (lower panel) climate (A2 scenario).

References

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