Impact of simulated present and historic management regimes on forest carbon cycling in Europe

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Background & Questions

Climate change mitigation aims:

- Increase C storage in forests
- Replace fossil fuel, concrete, … by wood
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Scenarios:
- Unmanaged
- Managed
  - Clear cut vs selective harvest
  - Actual vs natural species

Effect on
- C pools and fluxes
- Species distributions
- Yields
Methods

- Present and historic management (harvest demand, species)
- Atmospheric CO₂, soil texture, N deposition
- Climate (temperature, precipitation, radiation)

LPJ-GUESS
(Dynamic global vegetation model)

Simulation of
- C & N cycle
- H₂O
- plant and soil processes
- their interaction as well as
- exchange with the atmosphere
- competition

For each gridcell in Europe:
- C-fluxes
- C-pools
- Species distributions in mixed forests
- …
Results & Discussion

C-pools: mean for Europe's managed forests for yrs 1995-2010

- Europe forests would store 1.73 times more C if they were unmanaged
- Largest differences occur in the vegetation C pool (3.25 times more C)
- Hardly any changes in soil C as: differences in litter are less pronounced and root litter has a higher proportion
- Forests with natural species composition store 1.33 times more C than planted forests
Monocultures vs mixed

A natural species composition could increase the C stock without reducing harvested yield. Especially in N-Europe, and NE-Europe but there is potential in all countries.
**Monocultures vs Mixed - Explanation**

Percentage of each species on total vegetation C in Europe

- Pine is widely planted but has relative low vegetation C
- Global review: Ø 23. 7% higher productivity in polycultures than in monocultures (Zhang et al. 2012) due to niches and positive interactions (e.g. Richards et al. 2010)
Clear-cut vs Selective harvest

- Selective harvest results in higher C storage in vegetation and larger harvested yield

SH = selective harvest
CC = clear cut
Clear-cut vs Selective harvest – site scale

- France: SH => beech, stores more C than spruce mixed with others, resulting from CC
- France: SH, 50 years rotation => Pinus nigra dominates => lower C
- Sweden: CC => spruce mixed with pine and birch stores more C than spruce, resulting from SH

Location, rotation period length and (resulting) species composition matters!
Conclusions

- Growing demand on harvested products (substitution of fossil fuel, concrete, …) could further reduce the C in forest vegetation, but:

- Stored C in forest soil might be concerned to a lesser extend

- There are management options for increasing C stock without reducing harvested yield (adjusted species selection, harvest method and intensity)

Thank you for your attention!