Forest management and soil organic carbon
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Forest management and soil organic carbon

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#EUGreenWeek
19–22 OCTOBER 2020
Forest management and soil organic carbon

# IPCC Report 2018 → Keeping the average temperature increase below +1.5°C implies achieving carbon neutrality on a global scale by 2050 at the latest.

Two complementary levers

- Reduce CO2 emissions related to the use of fossil fuels and deforestation, as well as emissions of other greenhouse gases (N2O, CH4)
- Preserve and increase the biosphere's CO2 sink (storage in biomass and soils)

Today, focus on the soil organic carbon

Forests play a major role in climate change mitigation because of their carbon cycle (C)

- in France, 28% of the emissions captured by the forests (biomass and soils).
# Soil organic carbon stocks and stock changes in different ecosystems

- **SUITMAs**
  - Variable
- **Vineyards**
  - ~35 tC/ha
- **Orchards**
  - ~50 tC/ha
- **Grasslands**
  - ~80 tC/ha
- **Forests**
  - ~10 tC/ha

[Stocks in 0-30 cm, from Martin et al, 2011 and ADEME 2014]

- **In average, forests have the highest SOC stock**
  - (taking forest floor into account – 90 tC / ha)

- **Key message 1**: SOC in forests is high and is not at steady state (C sequestration is still very high in France and seems to comply with the 4p1000 initiative)

- **Grasslands**
  - ~80 tC/ha
- **Forests**
  - ~10 tC/ha

**SOE sequestration in France**

- **Grasslands**
  - Sequestration réalisée (+ tendancielle -)
- **Forests**
  - ~0.35 tC/ha/year = 0.0043 % of the soil C stock (RENECOFOR) but with strong uncertainty

[Jonard et al. 2017], waiting for the second national soil survey to get more precise numbers

- **Forests**: +0.35tC/ha/year = 0.0043 % of the soil C stock (RENECOFOR) but with strong uncertainty

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# Forest management and soil organic carbon

## Key message 2: Topsoil C is younger and less stable than deep soil C: forest Management then may impact soil organic C

- **Deep C is more stable than top-soil C**
- **Soil type modulates the effect of depth on the stability of soil organic C**
- Between 0-10cm, 70% of C is young (less than 100 years, i.e. less than one or two rotation lengths)

Forest carbon pools are not equal in terms of their vulnerability to global change.
Key message 3: Thinnings have no impact on the forest floor, provided that the intensity of the cut is low or moderate; Thinning does not quantitatively impact the SOC pool.

Key message 4: Clearcuts that leaves harvesting residues on the soil generally do not affect C sequestration, as long as they do not disturb the soil. The risk of C loss increases with the initial size of the C pool.
# Impact of forest management

**Whole – tree harvesting**: large consensus in the literature, **Fertilization** with N: few papers

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**Whole tree harvesting**

Losses at all depths (-11% in average)

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Key message 5: Whole tree harvesting negatively affects the SOC, the impact increases under warm climates.

Key message 6: The impact of N fertilization on SOC is unclear (dose effect with a bell curve).

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Key message 7: There are probably many density experiments with SOC measurement, but the data are not sufficiently published/visible. The best stand density trade-off for SOC sequestration and drought resistance/resilience is unknown.
Impact of forest management

**Rotation length** – few papers, unclear effect

RENECOFOR: \( \uparrow \) SOC up to \(~100\) years

Key message 8: Extending rotations - and thus tending towards old-growth forests - can improve SOC sequestration over the long term (up to 50-100 years?). But strong interaction with the past history of the forests.
Impact of forest management
Species Effect – Literature relatively abundant, unclear effect

Key message 9: Many uncertainties remain. Identity is generally a more important factor than diversity. Functional diversity (conifers, nitrogen fixing species, ...) in relation with the climate could better explain the observed trends than specific diversity.
# Impact of forest management

## Conclusion

### Afforestation of cultivated or degraded soils (poor SOC stocks)
- Fast growing tree species
- Rotation length >50 years to maintain the inherited soil fertility
- Intensive forest management

[[e.g. Boulmane et al. (2017) - Ann. For. Sci.; Cook et al. (2016) - For. Ecol. Manage.]

### Forests with medium SOC stocks
- No whole-tree harvesting
- Increase SOC stocks with nitrogen fixing trees
- Reduce soil perturbations during harvesting and forest regeneration


### Forests with high SOC stocks
- Continuous cover
- No soil perturbation during harvesting


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Key message 10: Win-Win strategies can be built to produce wood for different purposes and continue to store C in forest soils. Keeping in mind that soil fertility (physical, chemical and biological) is a key driver and should be considered as a whole (not only C).
For more information on

Thinnings and clearcuts


Species effect