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The key role of soils in delivering ecosystem services in forests beyond C sequestration assessment

Case studies: Forests of South Korea and Southern Spain

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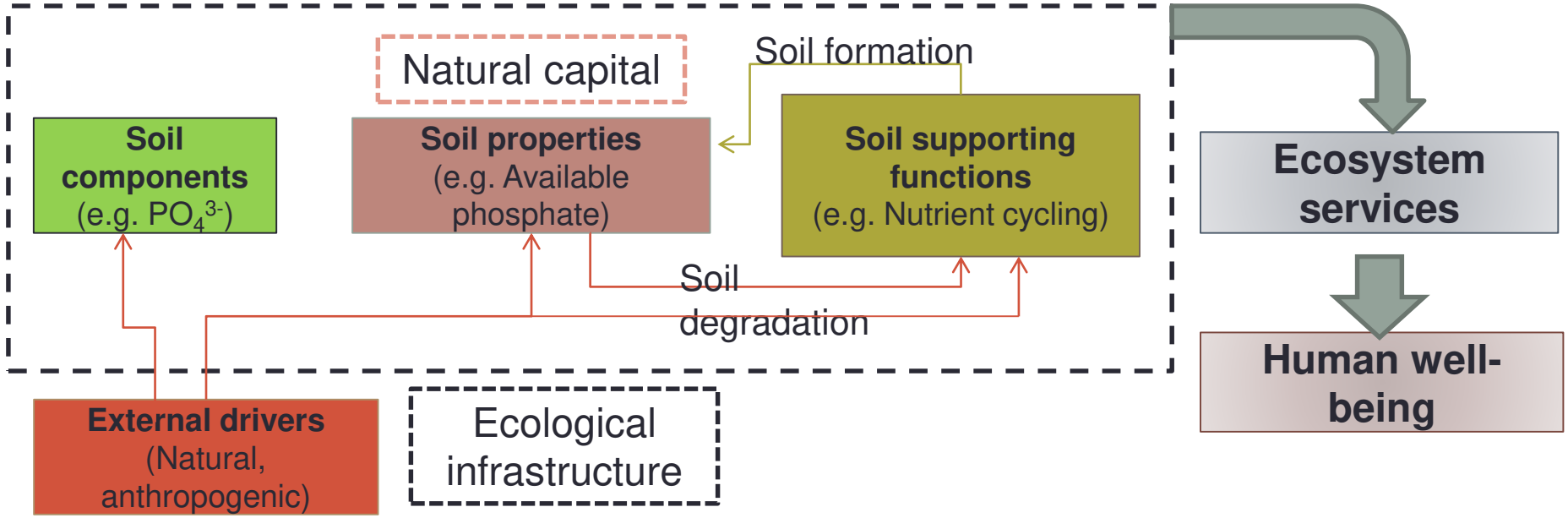
Reforestation and soils

- Most studies have assessed the C accumulation after reforesting by estimating the C accumulation in the biomass, and usually **do not take into account what is happening in the soil**, in terms of soil organic carbon (SOC) accumulation and the provision of ecosystem services.
- AIM: the aim of this study is to provide the **theoretical framework to assess the importance of soils in reforestation processes and show some preliminary insights about two assessments in South Korea and Spain.**

Components and drivers affecting soil ecosystem services

Adaptation from Dominati *et al.* (2010) and Jónsson *et al.* (2016)



SOC plays a key role on supporting services

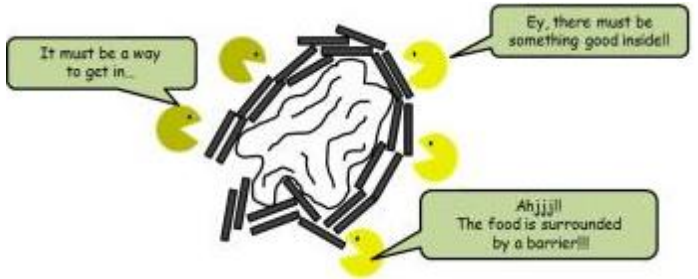
- SOC is a key indicator for soil quality and thereby "**soil security**" (Soil carbon initiative, 2011)
- SOC is the **main driver of most supporting functions.** Is not an inherent, but **a manageable soil property** (Dominati et al., 2010)
- A soil with **low organic C content is less resilient** and, therefore, the flow of the different ecosystem services might not be ensured at low SOC content

Soil	Soil parameter *Lal et al (2014)*
Physical quality	• Aggregation and structural stability • Tilth, resistance to crusting and compaction, and ease of cultivation • Aeration and gaseous composition in soil air • Water retention and availability • Water transmission (infiltration and percolation) • Heat capacity • Surface area • Soil strength/erodibility
Chemical quality	• Cation exchange capacity • Nutrient retention and availability • Buffer capacity (against Ph)
Biological quality	• Soil biodiversity • Food and habitat for soil biota
Ecological quality	• Net primary productivity • Use efficiency of input • Nutrient cycling and biogeochemical transformations • Carbon sequestration • Rate of new soil formation • Water purification • Denaturing of pollutants

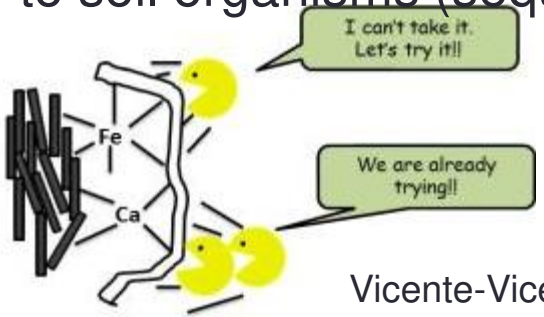
The SOC is formed by C with different dynamics

SOC can be split into different fractions according to its availability for the soil organisms.

- **Unprotected SOC:** fresh organic matter, easily decomposable (not sequestered SOC)
- **Protected SOC:** the SOC is not accesible to soil organisms (sequestered SOC)



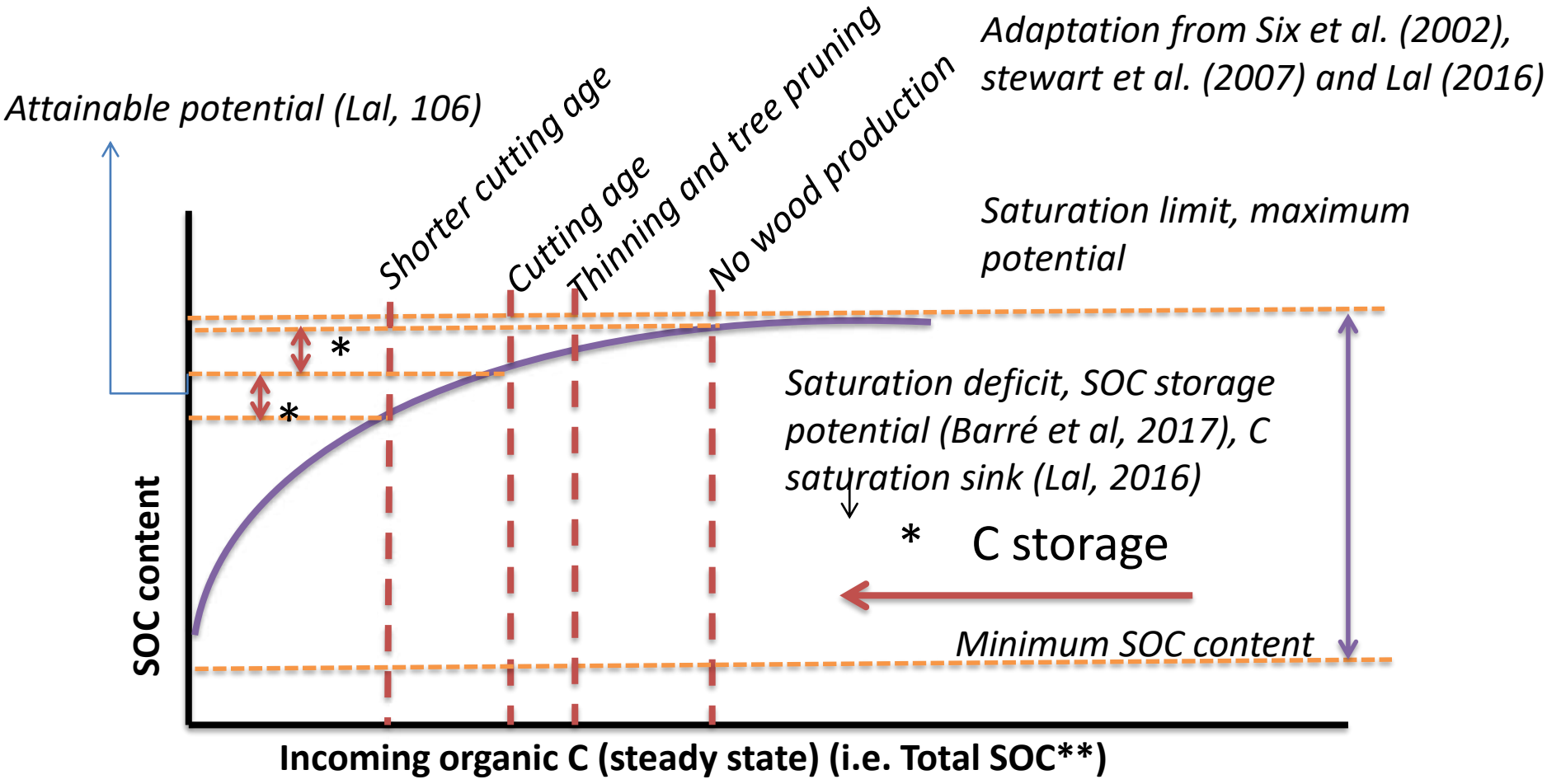
Physically protected
f (soil texture and physical properties)



Chemically protected
f (silt and clay content, cations)

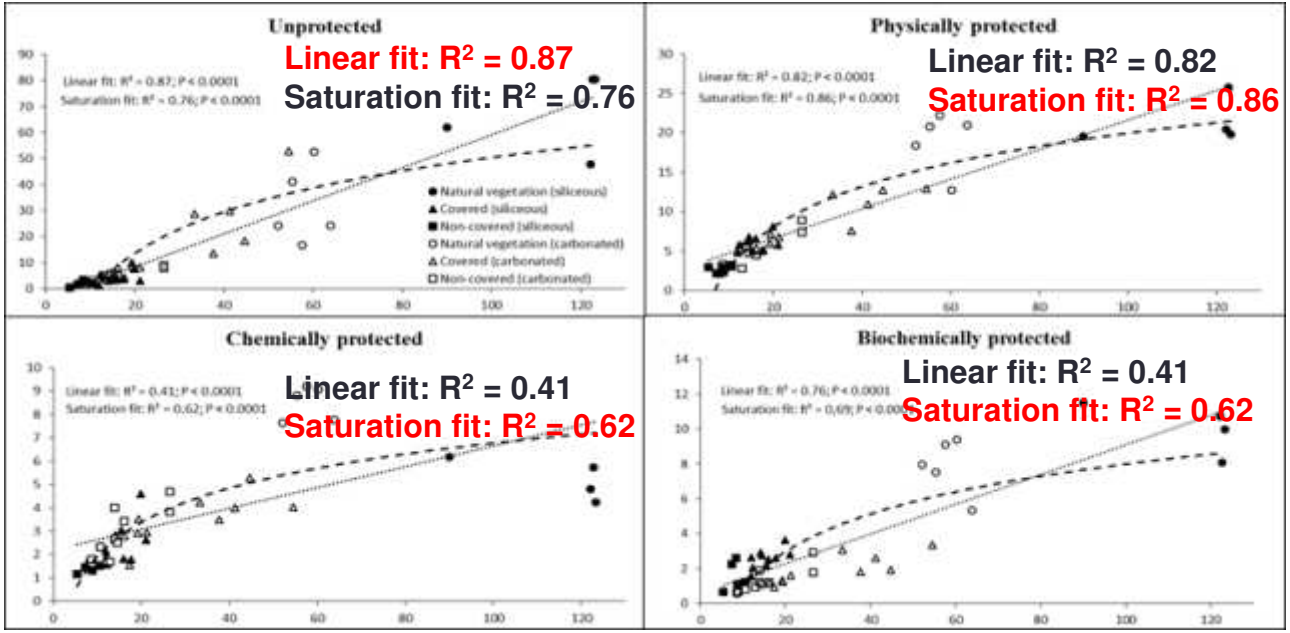
Biochemically protected
f (quality of the organic C)

Vicente-Vicente (2017)



**Linear direct relationship between incoming organic C, biomass production and total SOC

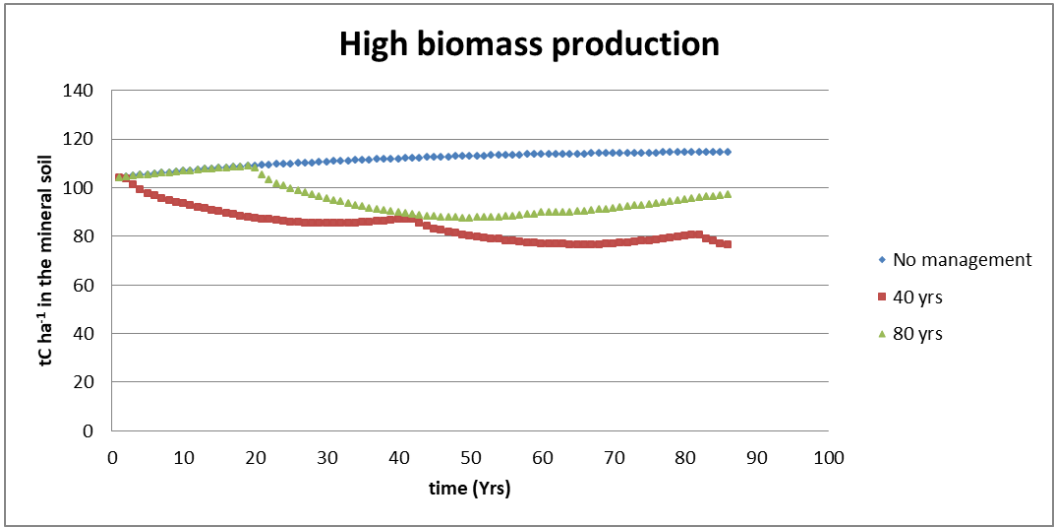
SOC fractions dynamics in soils. Case study in Andalusia (Southern Spain)



Forests with high biomass production (i.e. high total SOC content) **might have similar sequestered SOC than forests with lower biomass production**

Therefore, it would be possible to **implement some forest managements without strongly affecting the amount of sequestered SOC and so the resilience of the**

Possible managements: timber extraction and reducing cutting age in South Korean forests

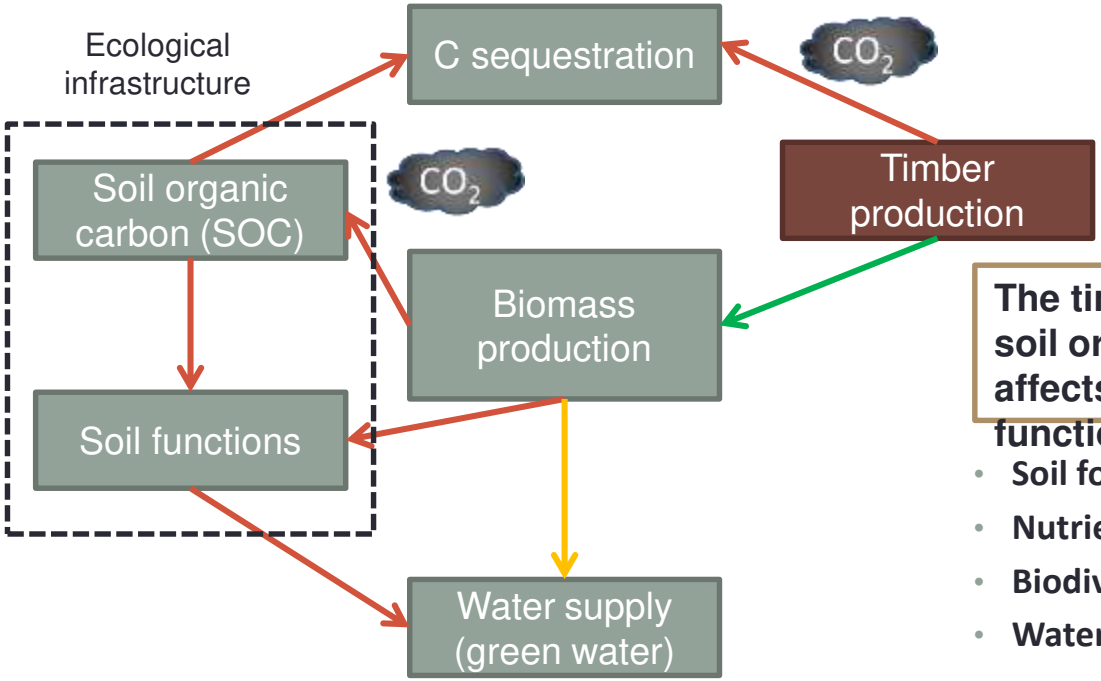


Example of a grid of 1 x 1 km

- The FBDC model was applied (Lee et al 2014, 2016) to predict the SOC dynamics in Korean forests (86 yrs)
- 2 managements (both include thinning and pruning)
  - Timber extraction (cutting each 40 yrs)
  - Timber extraction (cutting age each 80 yrs)

- 80 yrs management: loss of **17 tC ha^{-1}** after 66 yrs of the cutting and a tendency of reducing this difference
- 40 yrs management: loss of **38 tC ha^{-1}** (**0.44 tC ha^{-1} yr^{-1}**) after 86 yrs of the cutting and a tendency of increasing this difference

Consequences of the SOC decrease on ecosystem services and soil functions

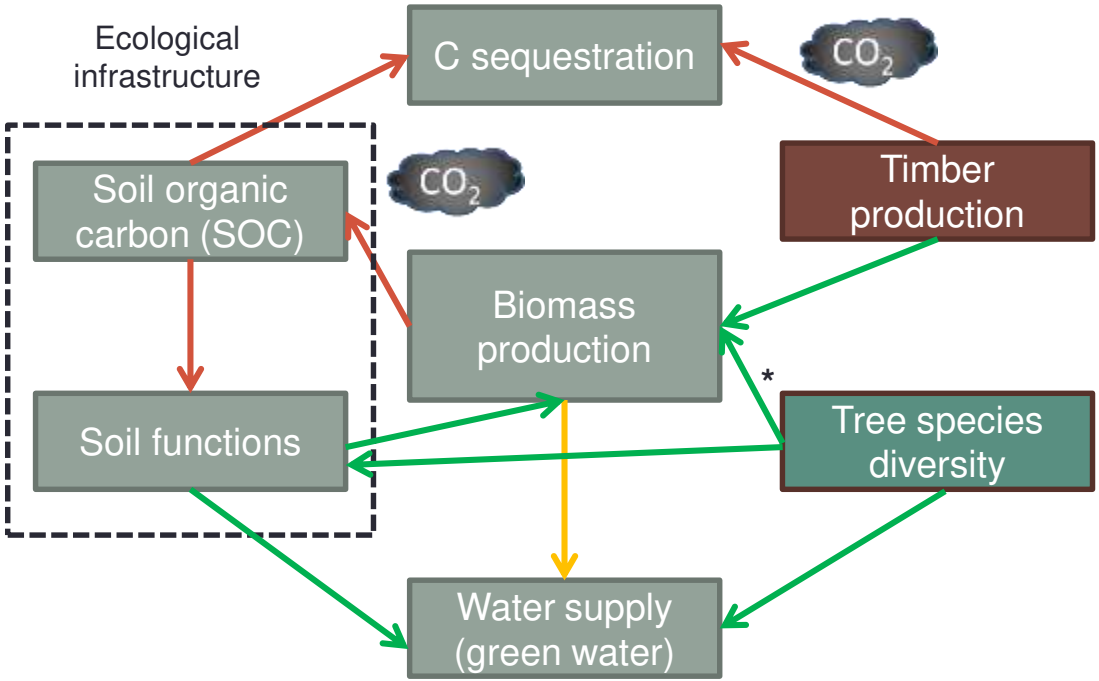


The timber extraction decreases the soil organic carbon content and affects negatively the soil supporting functions

- **Soil formation** (substrate)
- **Nutrient cycling** (soil fertility)
- **Biodiversity pool**
- **Water cycling**

↓ Soil resilience

Effects of increasing tree species diversity on ecosystem functions



*Personal communication of Moonil et al (PhD Thesis ,2018)

The loss in soil functions as a consequence of the decrease in the SOC could be **compensated by increasing the tree species diversity**

Our future research will be focused on assessing and quantifying how the soil components of the ecological infrastructure (i.e. soil supporting functions) are affected by the different managements and how these functions affect the provision of other ecosystem services

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THANK YOU VERY MUCH

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