


C storage in Amazonian pastures: effects of age, climate and management

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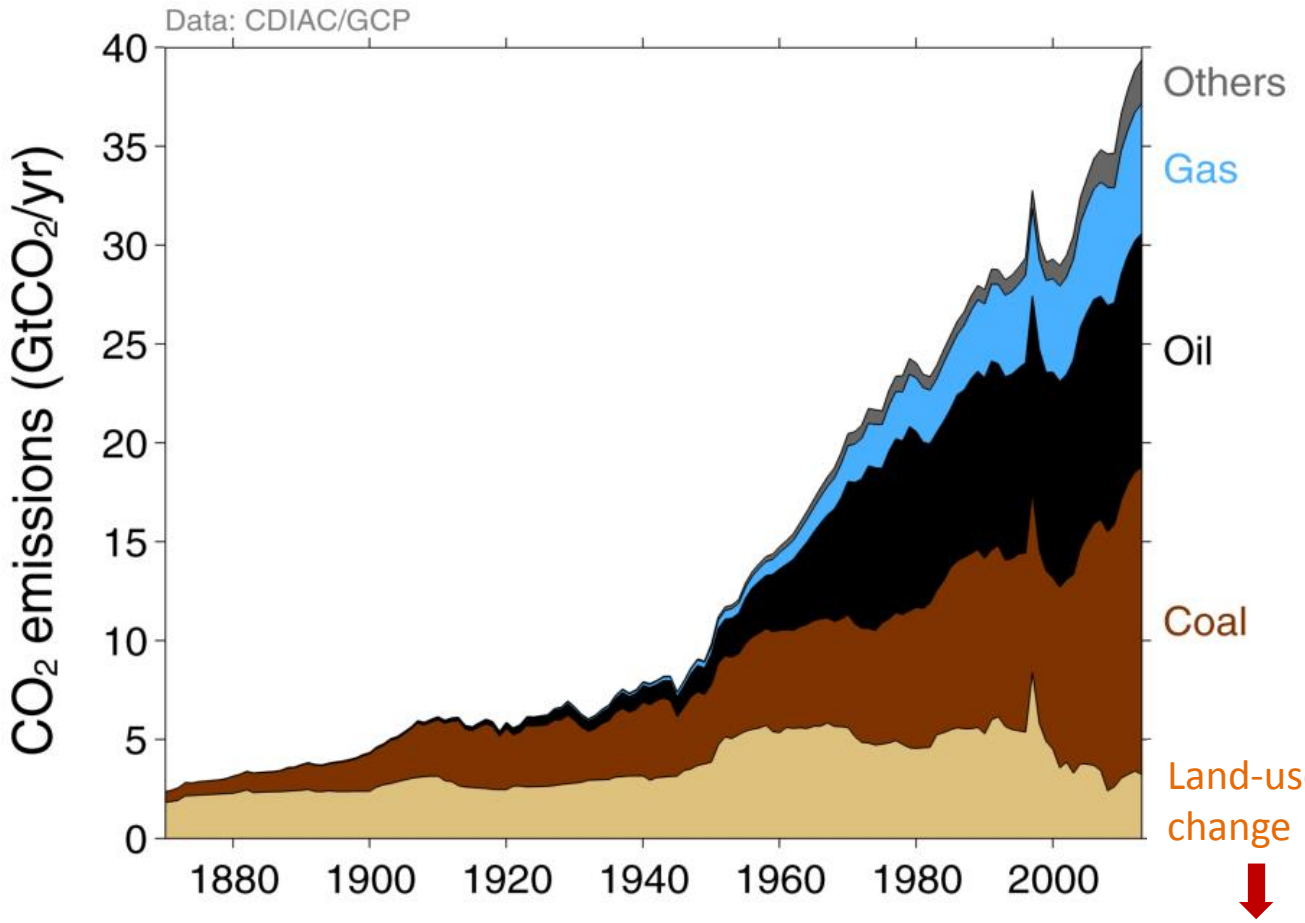
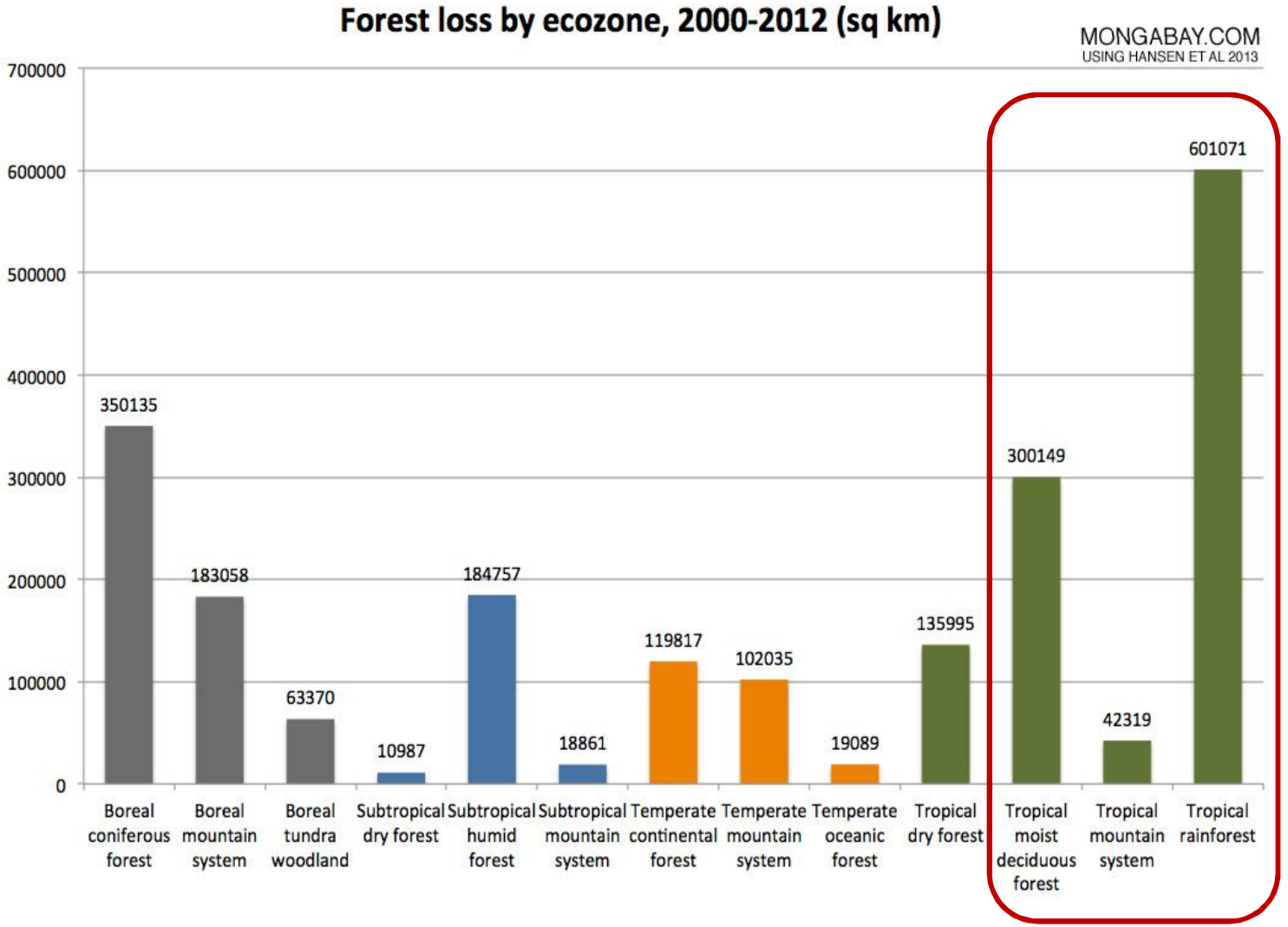
Contribution to climat change



Mainly deforestation

Å Deforestation

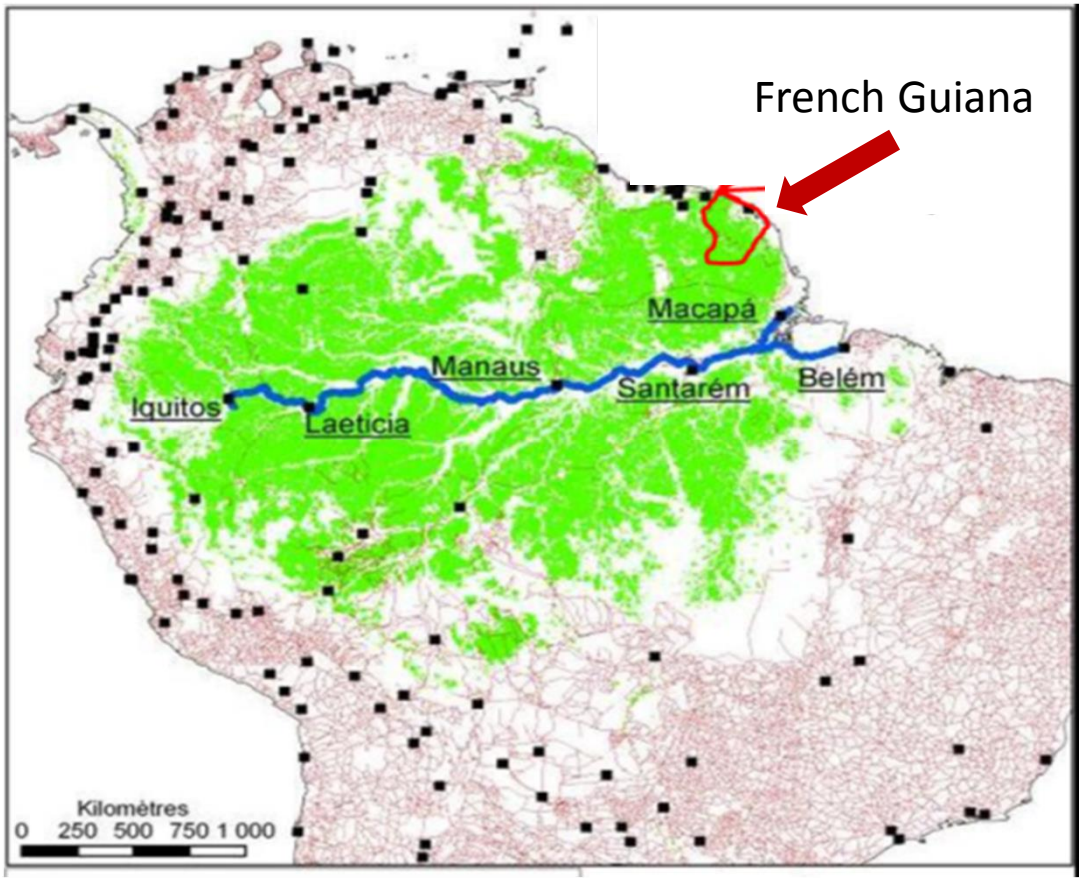
-> Large contribution of tropical rain forests



Tropical Forests

World tropical forest

- **40% Amazonian forest**
- **Annual C sink 0.4 -0.6 Gt C yr^{-1}** (Davidson, et al. 2012)



Å Deforestation French Guiana (1960 – 2011)

>20% of the area were transferred for livestock production

200 – 400 t C ha^{-1} C emissions (i.e biomass burning, litter decomposition)

Å Pasture establishment with C4 species (*Brachiaria* sp)

without management plan (i.e. grazing rotation, animal stocking rates, …)

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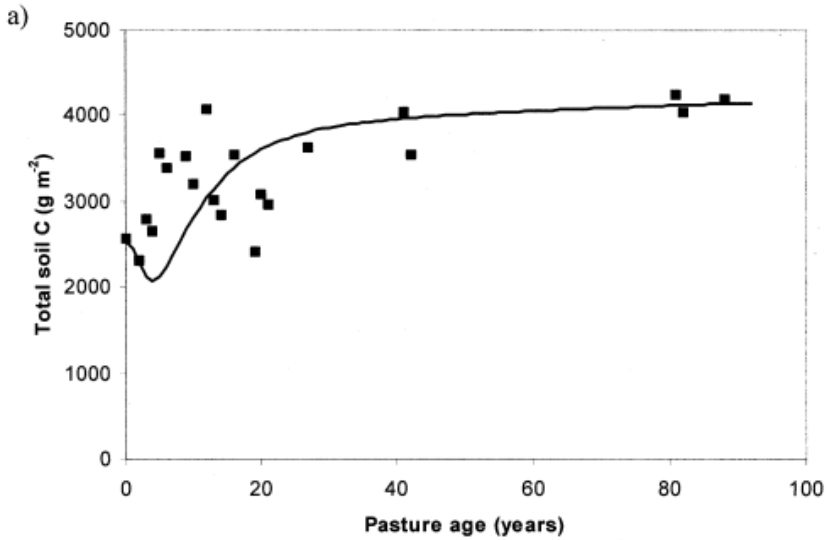
SOC stocks after Deforestation

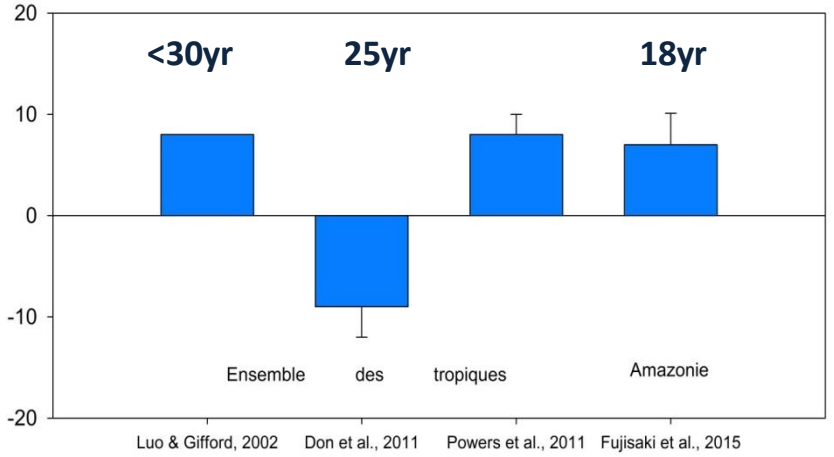
- **SOC stocks are predicted to be maximal in the first years, and decrease thereafter**

(Lal, 2004)

- **SOC accumulation (0-30cm) often ceases after a few years of pasture establishment**

(Cerri et al., 2004)





Variation in soil C stocks (%) after pasture establishment (0-30cm)




Question

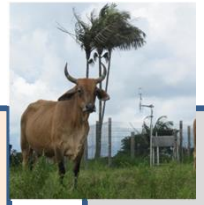
i) Can tropical permanent pastures restore soil C stocks after deforestation and to what extend ?

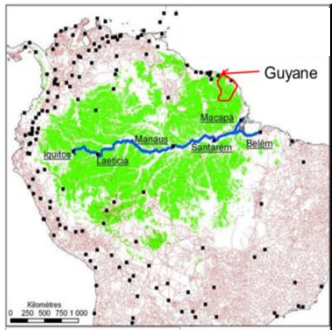
ii) Do pasture and pasture management store C in the long-term?

iii) Which role play management practices with respect to climate variability?

Amazonian Pastures in French Guiana

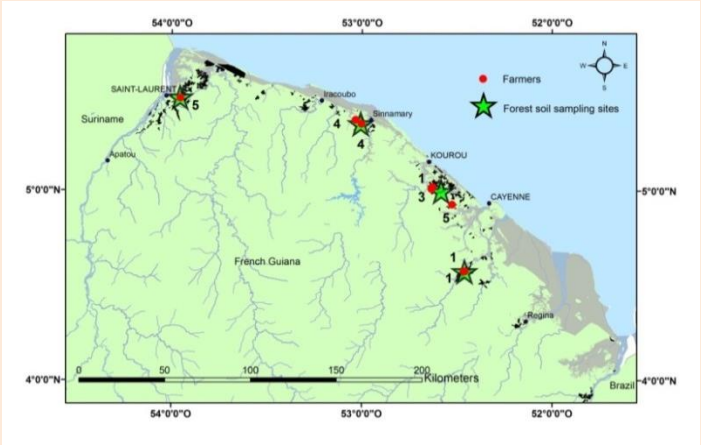
Å **C sequestration was estimated via two independent and complementary studies**





Chronosequence (0-38 yrs)

24 sites of grasslands (8 farms)
4 sites of natural forest
Soil C, N stocks
3 layers 0-20 / 20-50 / 50-100 cm
origins of vegetation (C3,C4; δ13C)

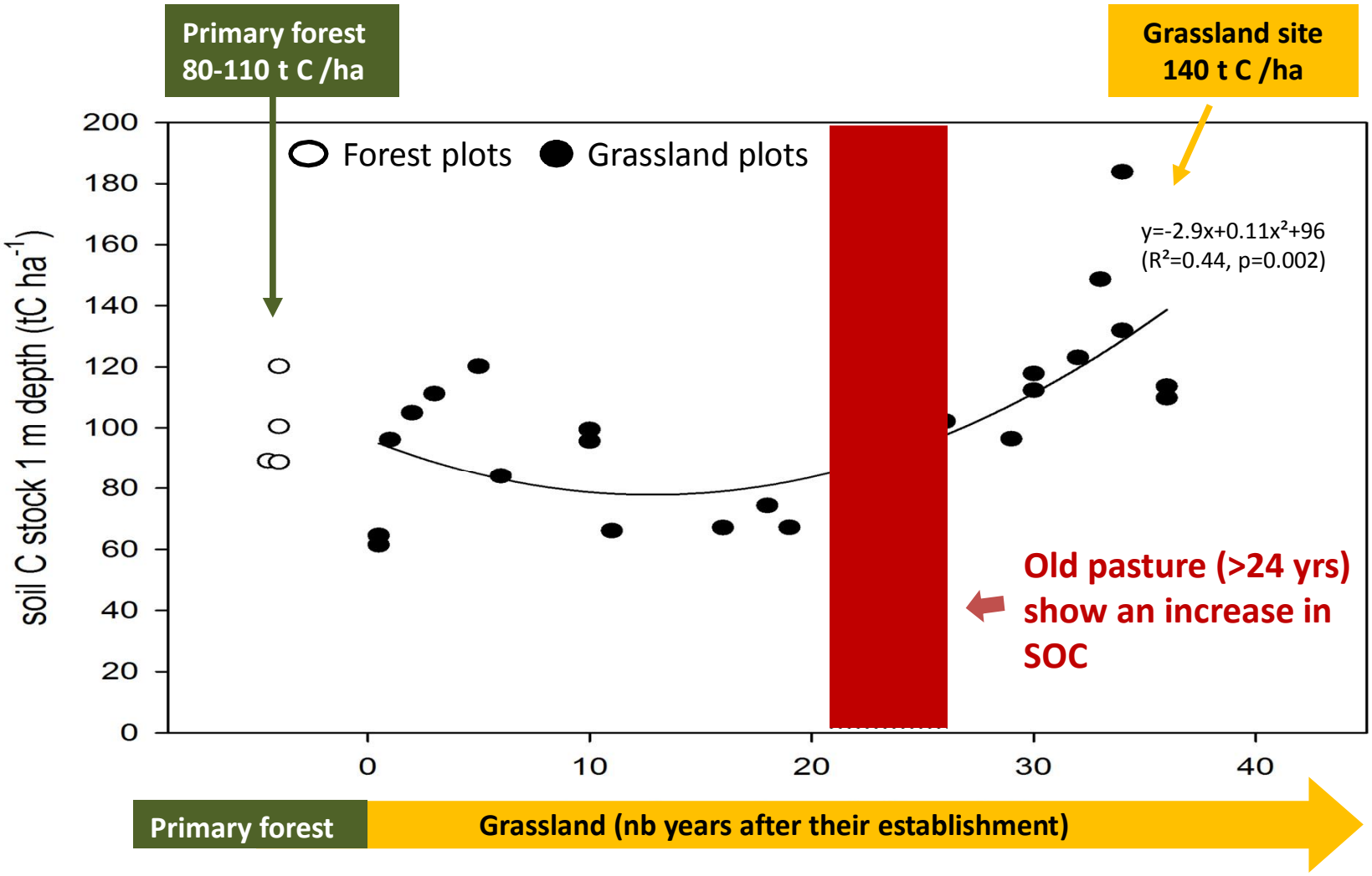


4 yrs Eddy Covariance CO2 flux measurements

- **Young pasture** (2008), grazed **high** stocking density 3.5 LSU ha^{-1} yr^{-1} (**intensive**).

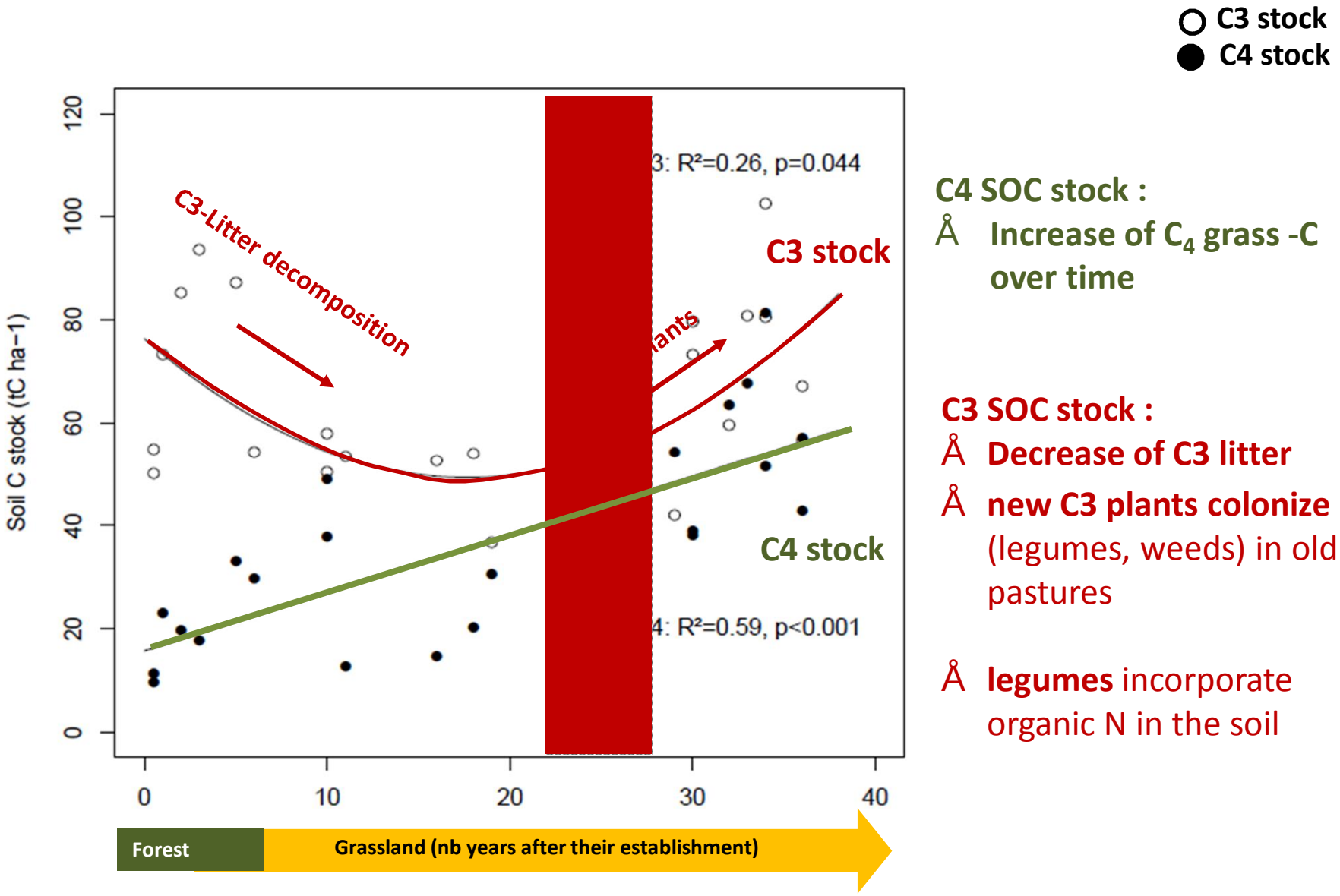
- **Old pasture** (1978), grazed **low** stocking density 1.1 LSU ha^{-1} yr^{-1} (**extensive**).

Soil organic carbon (SOC) stocks dynamics after deforestation



- **Notably, no C accumulation in surface layer (0-20 cm) but in deeper soil (20-100 cm)**

Origine of soil C stocks; C3 and C4 plants



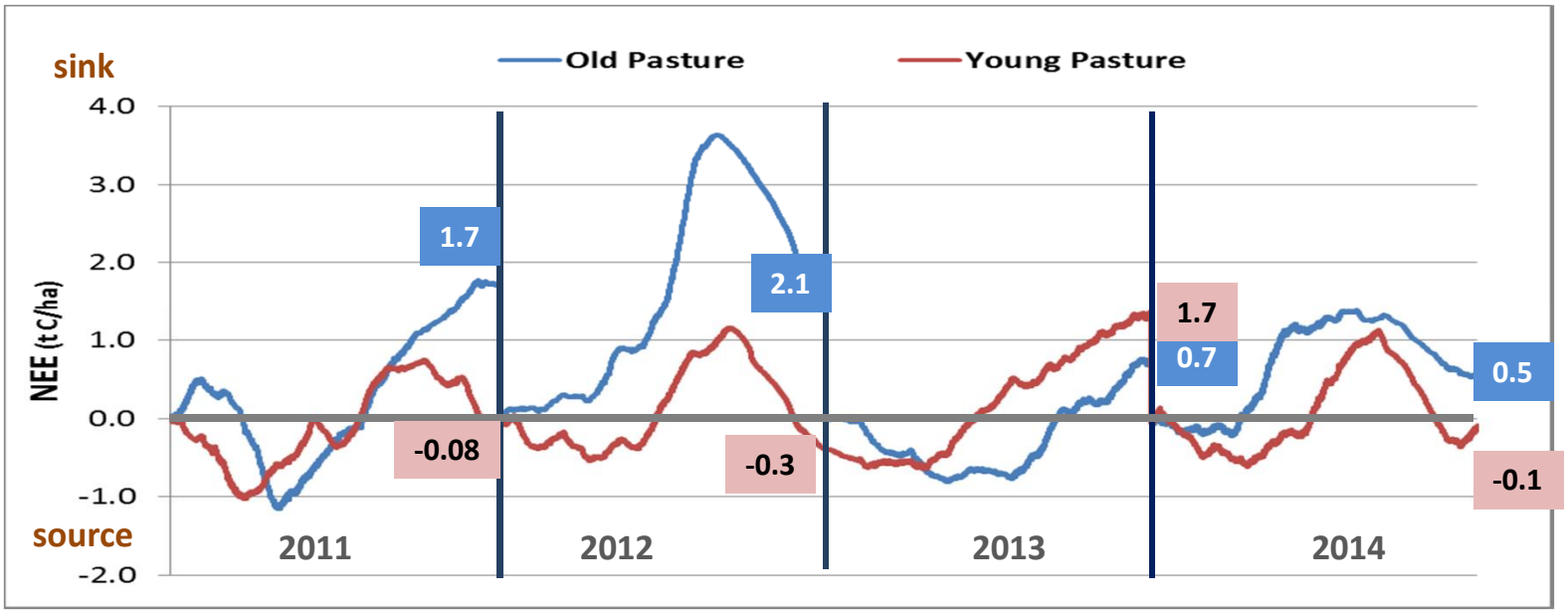
C4 SOC stock :

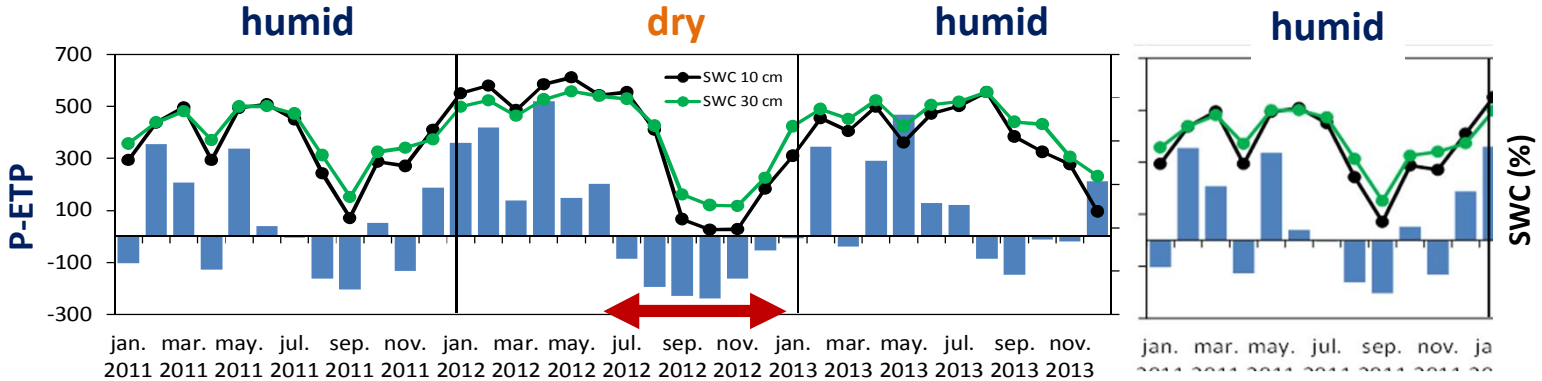
- Increase of C_4 grass -C over time

C3 SOC stock :

- **Decrease of C3 litter**
- **new C3 plants colonize** (legumes, weeds) in old pastures
- **legumes** incorporate organic N in the soil

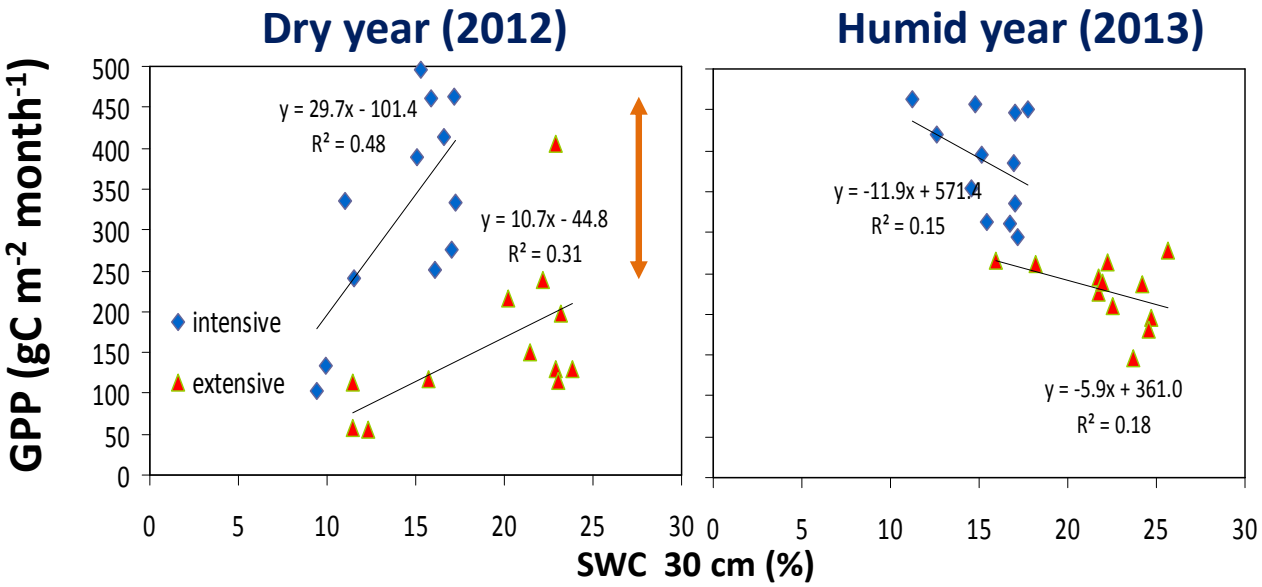
Eddy flux results: Net Ecosystem exchange





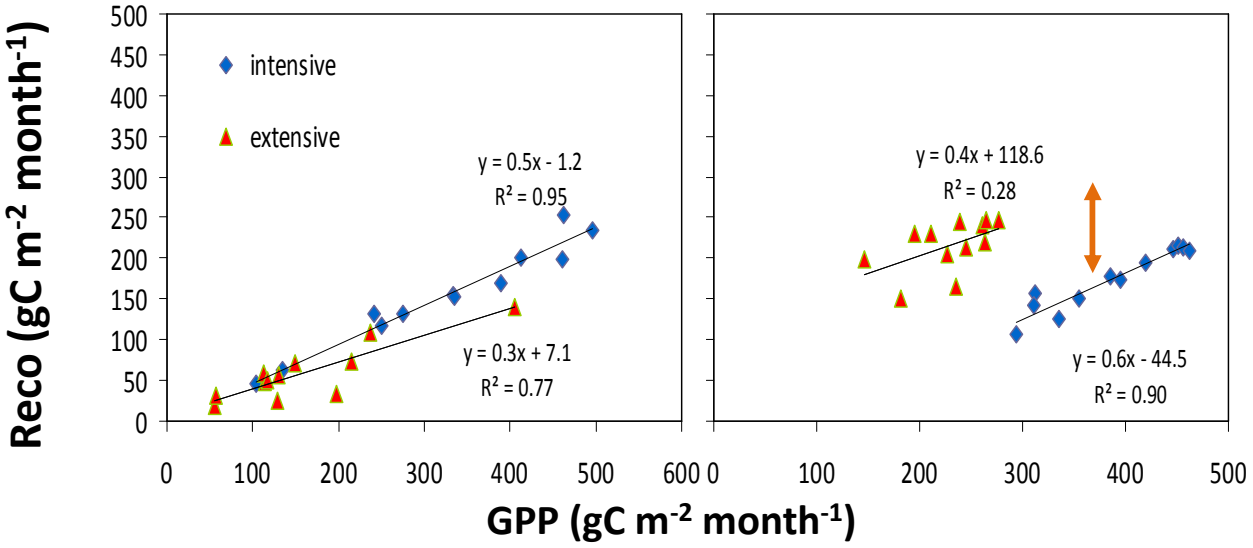
Seasonal variation of NEE linked to climatic variability and management

Ecosystem functioning (GPP and Reco)



Young – intensive Pasture

Old – extensive Pasture



Dry years

GPP *vs* SWC int > ext

Reco/GPP : int = ext

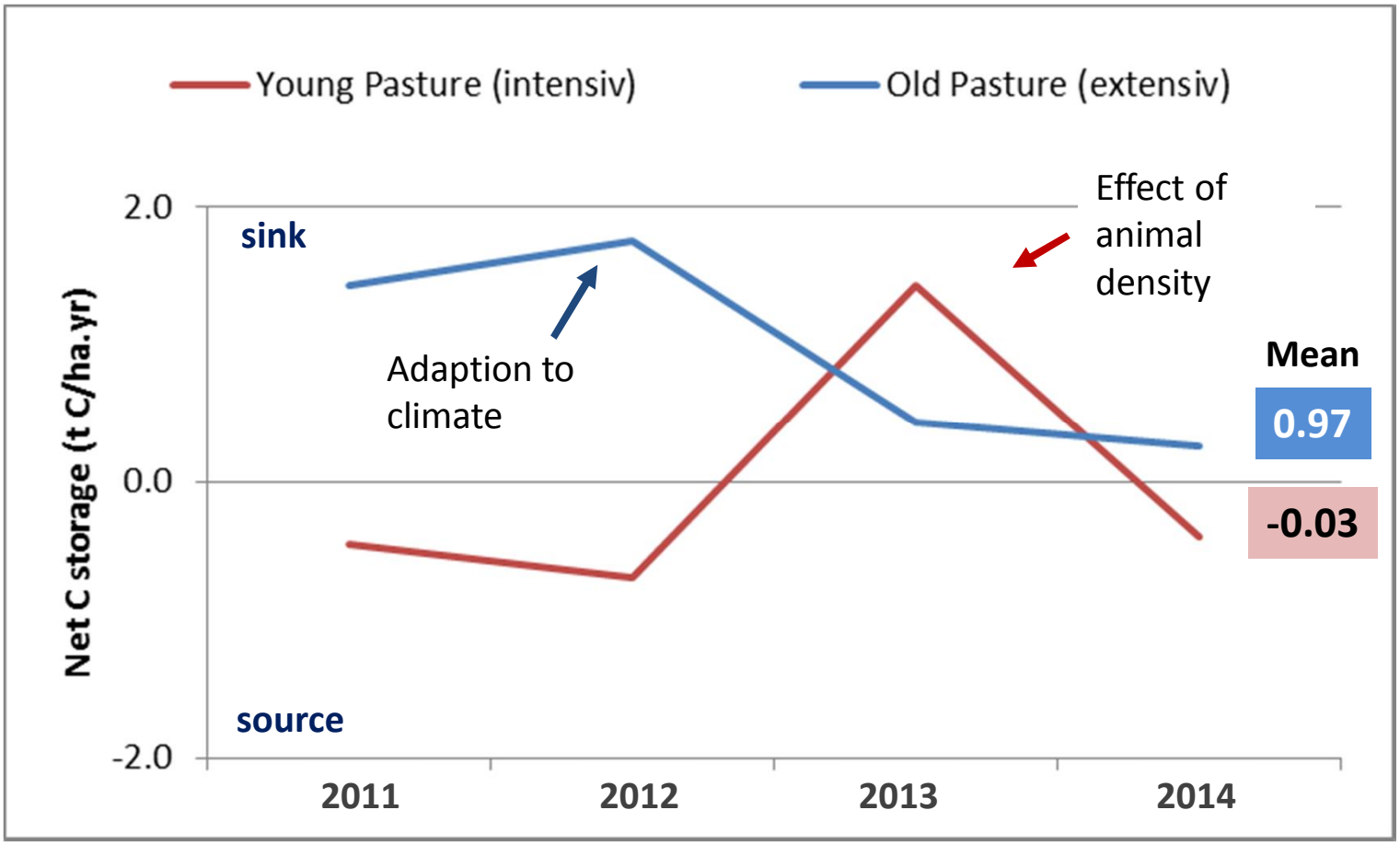
Humid years

GPP *vs* SWC int = ext

Reco/GPP: ext > int

Å Net Carbon storage (t C/ha.yr)

NCS= NEE-CH_4-Liveweight gain- leaching



Net carbon storage depends on climatic variability but also on management

Chronosequence vs. eddy flux measurements

- Eddy flux measurements

FOREST

2.6
tC ha^{-1} yr^{-1}

Young PASTURE

0.03±0.5
tC ha^{-1} yr^{-1}

Old PASTURE

0.97± 0.4
tC ha^{-1} yr^{-1}

- Chronosequence

100 ± 7tC ha^{-1}

85 ± 5 tC ha^{-1}

149 ± 10 tC ha^{-1}

SOC change 64 tC/ha in 29yrs
= 2.2 tC/ha.yr

Conclusion

- Pastures with sustainable management (*no fire, moderate animal stocking rate, species mixture, legumes*) are **a C sink in the long term**.
- For sustainably managed pastures, C sink activity can compensate C losses linked to deforestation.
- Differences between dry and wet years lead to a high inter- and intra annual variability in C storage.
- Pasture management can mediate climate effects. E.g. low vegetation cover and biomass seems to compensated for extreme soil water conditions between wet and dry season.

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