EFFECTS OF TREE ALLEYS ON SOIL STRUCTURE AND FERTILITY

A general pattern ?

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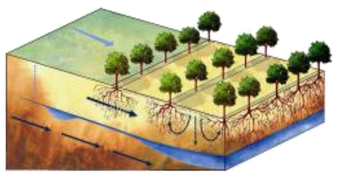
Why ?



In European agricultural landscapes, conventional farming is often described as a factor incrementing **soil erosion** and affecting **soil fertility**

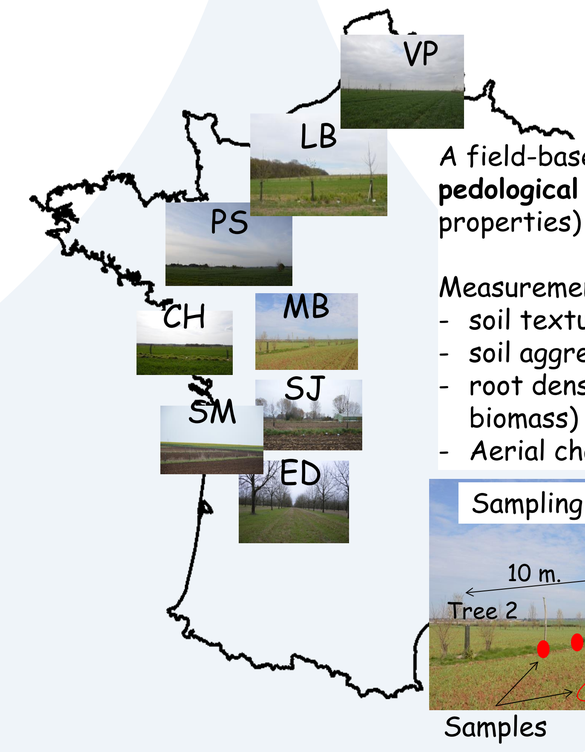
the ability of soils to resist erosion (= **Soil erodibility)**, can be assessed by measuring the **soil aggregate stability** (Le Bissonnais 1996).

Fortuna, A. (2012) The Soil Biota. Nature 1143Education Knowledge 3(10):1

Soil aggregate stability depends on physico-chemical properties of the soil (e.g. texture, carbonates), but recent studies showed also the involvement of vegetation-linked factors (e.g. **soil organic matter**, **roots presence)** (Graf and Frei 2013, Pérèz et al. 2013). However the hierarchical contributions of all these factors are still unclear, and agroforests systems with **tree alleys design** are particularly interesting models to disentangle the influences of vegetation and pedological properties on soil structure and fertility improvement.

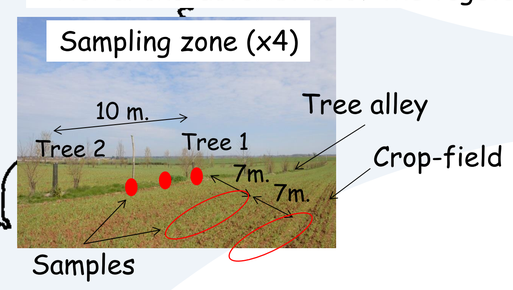
1. What are the main drivers of aggregate stability ?
2. Is agroforestry an appropriate practice to improve soil structure and fertility ?

How ?



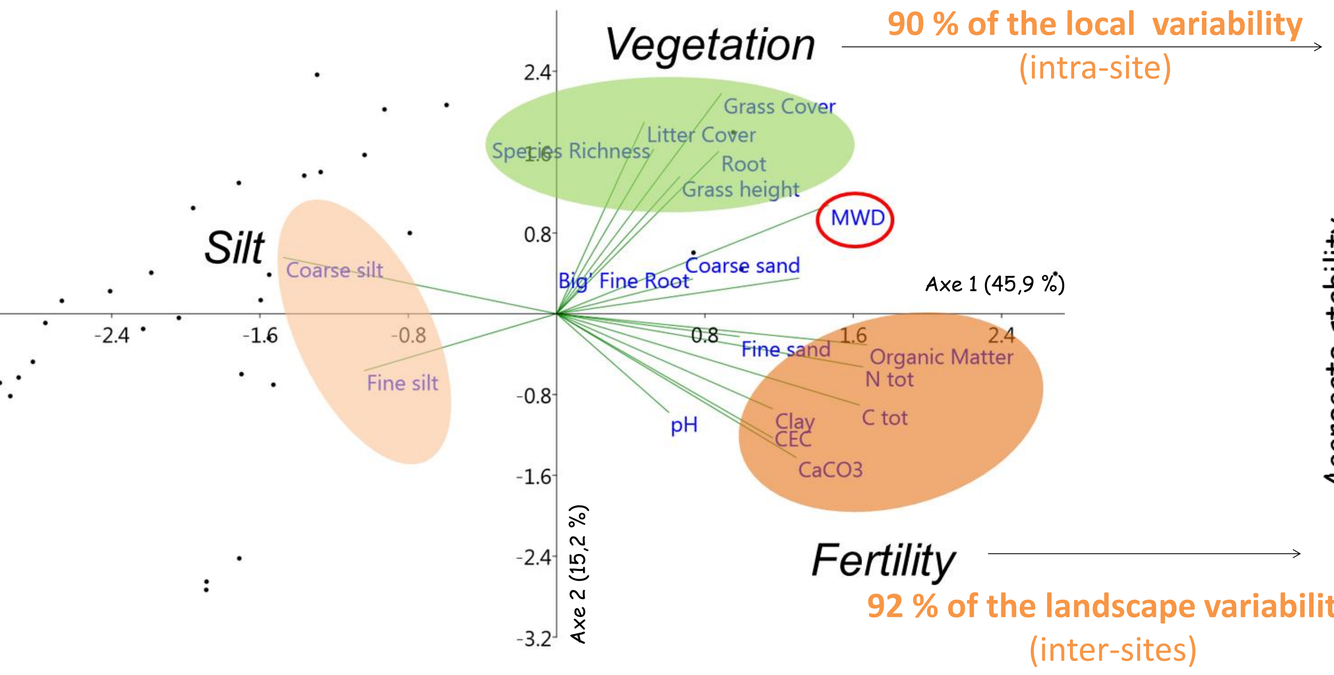
A field-based sampling on **8 sites** distributed along a **pedological gradient** (variations in textural and chemical properties) with 4 sampling zones in each site.

Measurements :
- soil texture and physico-chemical properties
- soil aggregate stability (Mean Weight Diameter, MWD)
- root density, coarse root proportion ($g.g^{-1}$ total root biomass)
- Aerial characteristics of the vegetation



1. Drivers of aggregate stability: a matter of spatial scale

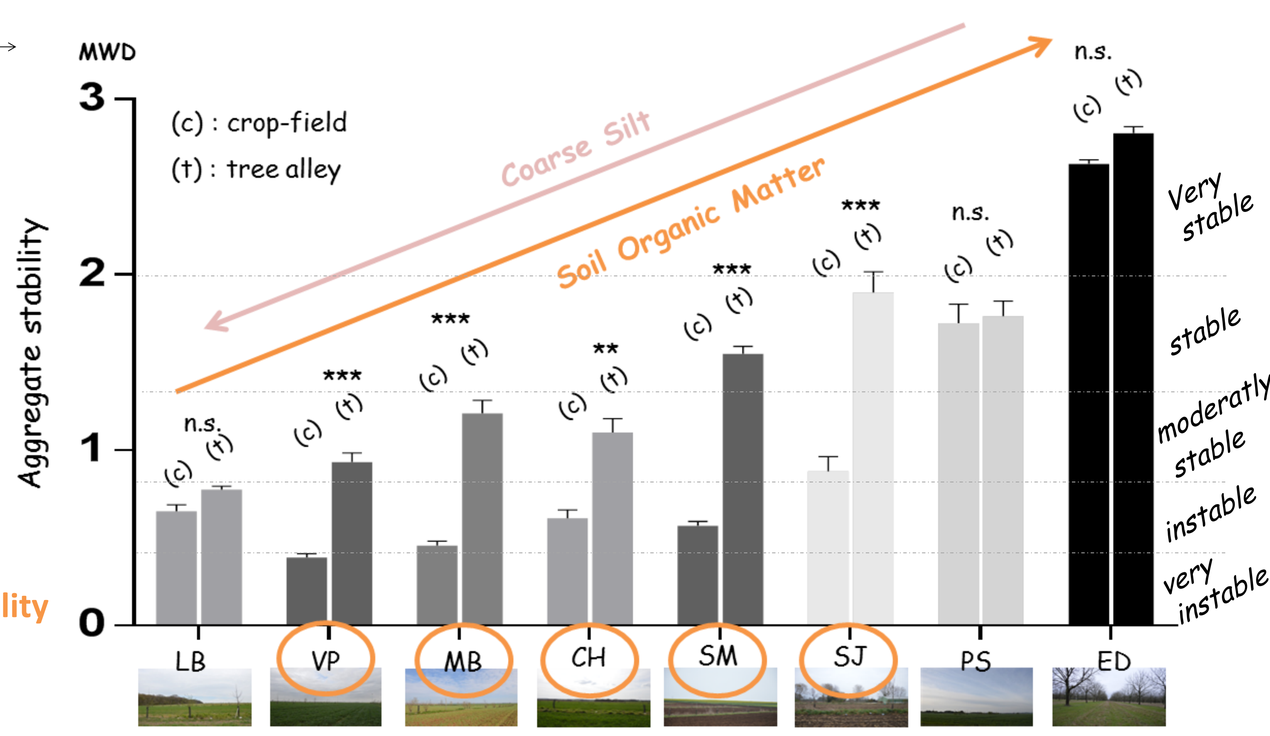
Relations between variables (PCA analysis)



90 % of the local variability (intra-site)

92 % of the landscape variability (inter-sites)

Effect of the tree alley on the aggregate stability along a pedologic gradient



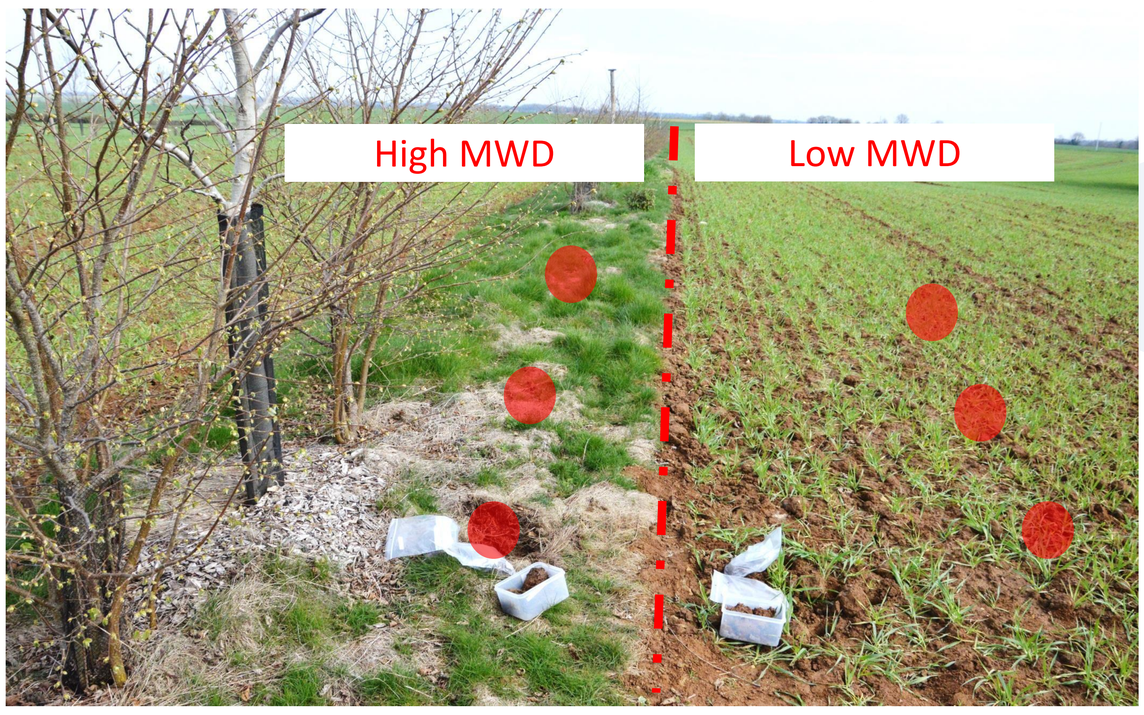
At the **landscape-level** the variability in MWD is explained by the **pedological conditions** (Organic Matter *vs* Coarse Silt)

At the **local-level**: increase in MWD due to **perennial vegetation** (litter cover, coarse root proportion) from critical to good levels of stability (only in 5 sites in the **middle of the pedological gradient**)

=> **Hierarchy between groups of drivers** (vegetation *vs* pedological) across spatial scales: extreme pedological conditions at landscape-level cancel effects of the vegetation at local-level (LB, PS, ED).

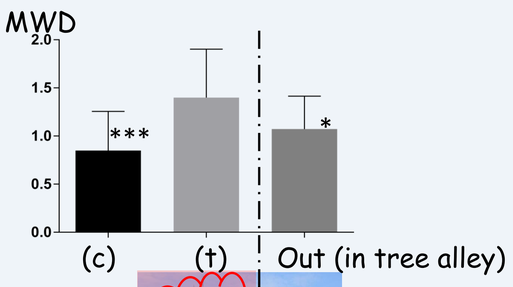
2. No effect in the crops zone ? Let's give time to trees…

Tree alley **Crops zone**



=> No influence of trees on the crops zone… BUT !

An effect of the **Crown presence** in the alley …



explained at 100% by higher **'coarse root proportion'**

II
V

Among our variables, 'coarse root proportion' is the variable better explaining the influence of trees on the soil aggregate stability.

Too young systems for long-term process…
It is important to consider that sites sampled here are 'young' tree alley systems (plantation <10 years), i.e. that a more pronounced root colonization of the crops zone is expected for next years, as much as an exponential input of aerial litter, both mechanisms being involved in improvement of in soil organic matter and soil structure.

Conclusions & Continuation

. Multi-sites approach highlights the relative contribution of drivers of aggregate stability at different spatial scales : pedological gradients (coarse silt *vs* SOM) at landscape level, and markers of perennial vegetation at local level.

. A new sampling design with hedges to assess effects of 'old' tree alley systems on the adjacent crops zone, through assessments of the soil-root-microbial continuum…

1. Graf F, Frei M, (2013) Soil aggregate stability related to soil density, root length and mycorrhiza using site-specific Alnus incana and Melanogaster variegatus s.l. Ecol. Eng. 57: 314-323.
2. Le Bissonnais Y, (1996) Aggregate stability and assessment of soil crustability and erodibility: I. Theory and methodology. European Journal of Soil Science, 47: 425-437
3. Pérès G, Cluzeau D, Menasseri S, Soussana JF, Bessler H, et al. (2013) Mechanisms linking plant community properties to soil aggregate stability in an experimental grassland plant diversity gradient. Plant Soil 373: 285-299.

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