Biochar application in forest soil in La Chapelle-Saint-Rémy (France)

EXPERIMENT GOALS

The experiment intend to investigate the medium to long-term effects of applying biochar in sandy forest soil susceptible to drought and erosion. In particular, the experiment will study the effects on
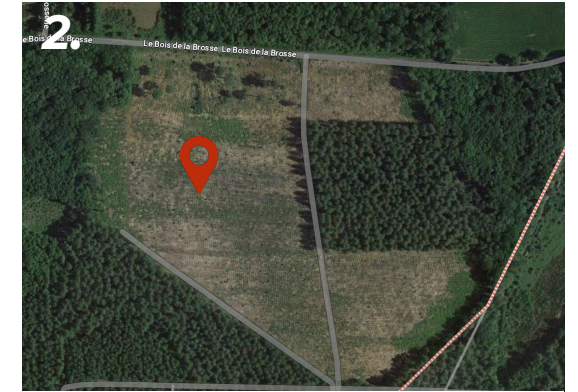
- soil physico-chemical properties
- soil biodiversity
- tree growth, resilience and forest natural regeneration

The biochar was provided by a biochar producer in France and was added at different application rates according to a Design of Experiment (DoE) including 8 plots of 0.5 ha each and three species of trees.

The experiment started in January 2022 and it is planned to last for 30 years

1.

Forest site north west of France - after a clear cut of Maritime Pine

2.

Sandy soil susceptible to **drought** and **erosion**

3.

Douglas Fir - 7,5 tons biochar
Douglas Fir - 22,5 tons biochar
Douglas Fir - 15,0 tons biochar
Douglas Fir - 0 tons biochar
Maritime Pine - 22,5 tons biochar
Maritime Pine - 7,5 tons biochar
Maritime Pine - 15,0 tons biochar
Maritime Pine - 0 tons biochar
Maritime Pine - no biochar study
EcoTree site_whole
building
highway
boundary
OSM_landuse_forest

We added **biochar** 0, 15, 30, 45 tons/ha.
We planted **three species of trees:** Douglas Fir, Maritime Pine and Birch

4.

To study biochar effects on
- soil physico-chemical properties and biodiversity
- tree growth, resilience and forest natural regeneration

Site description

The research project is located north-west of France and is characterised by sandy soil and gentle slopes. The previous forest of Pinus pinaster (Maritime Pine) was clear cut, increasing the susceptibility of the site towards drought and erosion. The site was reforested with *Pinus pinaster* (Maritime Pine), *Pseudotsuga menziesii* (Douglas Fir) and *Betula pendula* (Birch).

Biochar

The biochar used in this research project was produced from woody biomass in a pyrolysis plant in France. Selected biochar characteristics (more available upon request) are the following.

- Bulk density < 3 mm: 166 kg/m3
- Specific surface (BET): 309 m2/g
- Water holding capacity (WHC) < 2mm: 120%
- Ash content (550°C): 8.8%
- Total carbon: 86%
- Organic carbon: 85%
- H/C: 0.23
- pH in Ca/Cl2: 7.9
- particle size distribution: < 5 mm (5%), 5 - 10 mm (49%), 10 - 16 mm (44%), > 16 mm (2%)

Metal, metalloids, PCDD/F and PCB were well below the threshold suggested by EBC for agricultural application. The same was expected for PAHs, but unfortunately the results of the chemical analyses, which arrived after the biochar was spread in the field, showed a PAHs concentration about 6 times higher than the limit recommended by EBC for agricultural application. For this reason, additional monitoring activities have been planned.

Biochar application in the field

The 90 ton of biochar were spread on 8 plots of 0.5 ha each according to the following Design of Experiment (DoE)

- plot 1: **0 ton/ha** and *Pseudotsuga menziesii* (Douglas Fir) & *Betula pendula* (Birch)
- plot 2: **15 ton/ha** and *Pseudotsuga menziesii* (Douglas Fir) & *Betula pendula* (Birch)
- plot 3: **30 ton/ha** and *Pseudotsuga menziesii* (Douglas Fir) & *Betula pendula* (Birch)
- plot 4: **45 ton/ha** and *Pseudotsuga menziesii* (Douglas Fir) & *Betula pendula* (Birch)
- plot 5: **0 ton/ha** and *Pinus pinaster* (Maritime Pine) & *Betula pendula* (Birch)
- plot 6: **15 ton/ha** and *Pinus pinaster* (Maritime Pine) & *Betula pendula* (Birch)
- plot 7: **30 ton/ha** and *Pinus pinaster* (Maritime Pine) & *Betula pendula* (Birch)
- plot 8: **45 ton/ha** and *Pinus pinaster* (Maritime Pine) & *Betula pendula* (Birch)

The biochar was spread with a manure spreader and mixed within the topsoil with a rotary tiller. Following these operations, the trees were planted.

MEASURED PARAMETERS

Trees: tree height & diameter, survival rate, natural regeneration

Soil physico-chemical properties (0-20 cm depth)
- Field measurements: soil compaction, redox potential, temperature
- Lab measurements: soil natural density, water balance (water capacity, field capacity, permanent wilting point), pH, total and organic carbon, effective cation exchange capacity (CEC), plant available N, P, K, Ca, Mg, S, Cl, Fe, B, Mn, Zn, Co, Mo, Cu, Si, PAHs

Soil biodiversity (0-20 cm depth)
- Fungal & bacterial community: DNA shotgun metagenomic sequencing + amplicon ITS sequencing for taxonomic and functional profiling
- Micro/meso/macrofauna: Assessing soil microfauna, mesofauna and macrofauna with Berlése apparatus

Soil chemical properties (20-40 cm depth)
- Lab measurements: PAHs

NUMBER OF SAMPLES

Trees: *120 saplings/plot, to ensure that at least 50 trees/plot will be available at the end of the observation period*

***Soil field measurements***: *60 points/plot for soil compaction, 4 points/plot for redox potential and temperature*

Soil physico-chemical properties *and* ***fungal & bacterial community***: *30 sub-samples/plot leading to 1 representative composite sample/plot (with representative sample mass reduction procedure)*

Soil micro/meso/macrofauna: *6 sub-samples/plot leading to 1 composite sample/plot*

MONITORING TIMELINE

All the measurements are carried out one time per year - possibly always in May - for the first five years, and once every five years thereafter.

Year   0 1 2 3 4 5   10   15   20   25   30
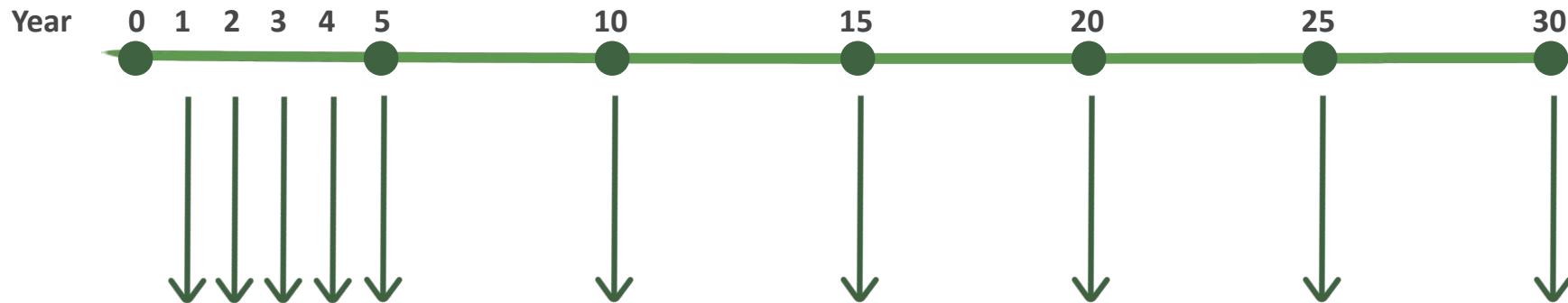
In field measurements + soil physico-chemical analyses + soil biodiversity analyses

PRESENTATION OF THE WORKING GROUP

This research project has been designed, managed and monitored by EcoTree. The execution, management and monitoring of the first year was financed by H&M.

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