How to give new value to moderately contaminated soil : assessment of wood energy production with short rotation coppice

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How to give new value to moderately contaminated soil : assessment of wood energy production with short rotation coppice

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Background and Objectives

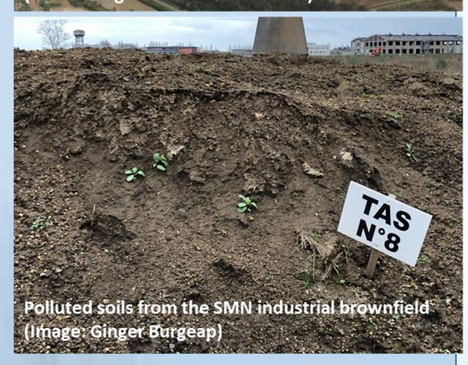
An emblematic site:

- A 150 ha former iron and steel site being rehabilitated (SNM in Colombelles, suburb of Caen, France),
- Major constraints in relation to the establishment of productive plant cover (agronomic properties and soil pollution),
- Recommendations of good practices to avoid the costs of excavation and disposal to landfill, while improving the carbon footprint of development operations

Main objectives:

- Producing knowledge on the refunctionalization of moderately contaminated soil from an agronomic point of view, to produce wood biomass for energy purpose
- Restoring the fertility of the land with regard to needs of selected crops
- Producing, in quantity, healthy biomass with high energetic value and quality
- Contributing to soil management regarding pollution stabilization of Metallic Trace Elements (MTE) and through the potential degradation of organic pollutants as Polycyclic Aromatic Hydrocarbons (PAHs) and Total Hydrocarbons (THC).

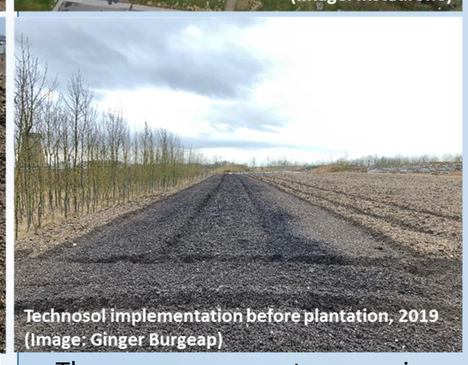

Société Métallurgique de Normandie (SMN), France before cessation of activity in 1993 (Credit image: Fonds archives SMN)



Polluted soils from the SMN industrial brownfield (Image: Ginger Burgeap)

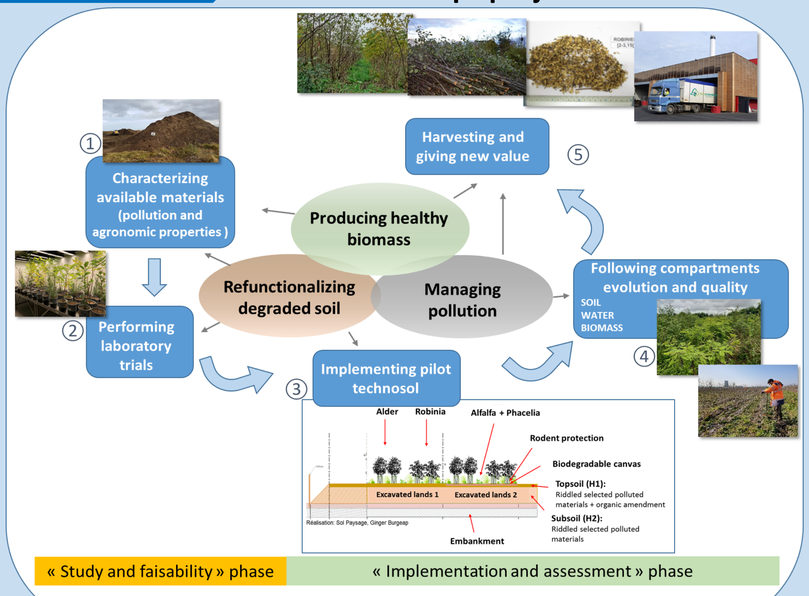
Material and Methods


Ex-SMN site in 2021 (Image: Instadrone)


Technosol implementation before plantation, 2019 (Image: Ginger Burgeap)

Three measurements campaigns : Initial (t0), after one vegetation season (t1) and after two after vegetation season (t2)

A five steps project:



- Earth materials available on site impacted in MTE, PAHs and THC after 40mm screening (T8<=T6<T12)
- Surface horizon: incorporation of 10 cm of compost on 20 cm of soil in place
- Ground cover: Alfalfa (75%) and phacelia seedlings (25%)
- Planting black locusts and white alders

⇒ **Proposing a methodology for stakeholders to understand the levers of actions around enhancing the energetic and economical outcomes of available brownfields awaiting for change and new use, while managing pollution**

Results and discussion

Phytomangement solution of the moderately contaminated site:

- Agronomic parameters (1 2):

- Significant impact of the organic amendement on agronomic parameters (CEC, N, P, K > in H1)
- Apparent homogenity and stability over time of parameters between the different initial materials (T8, T6, T12).

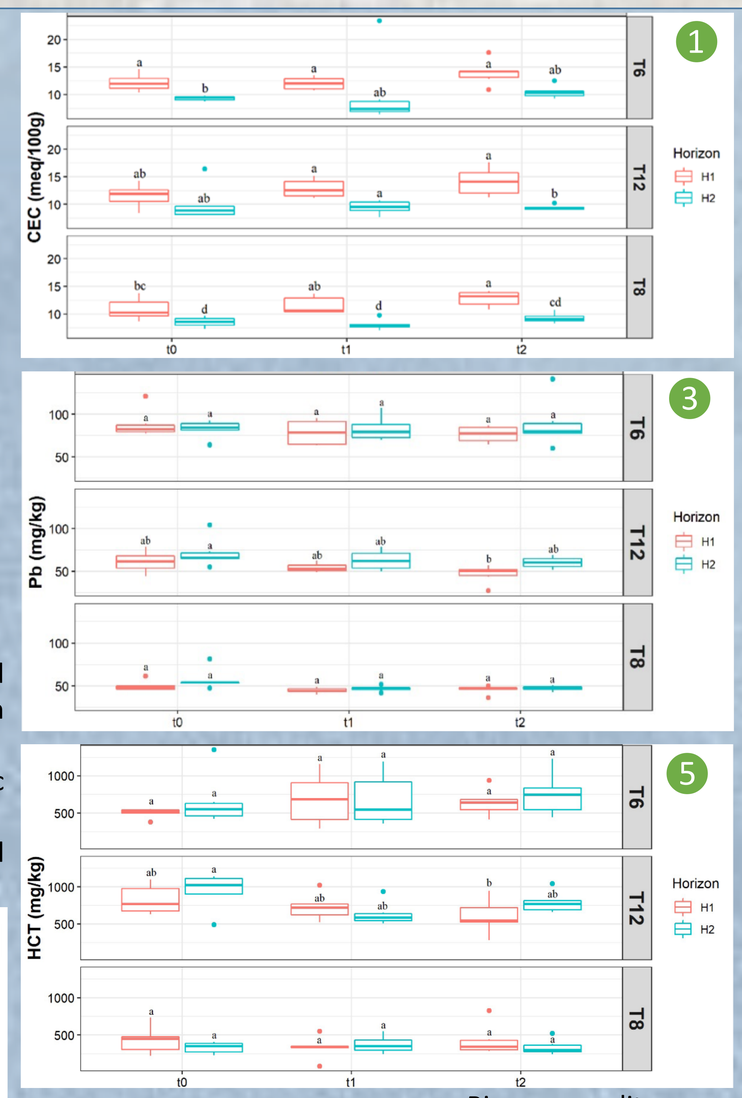
- Pollution parameters (3 4 5 6):

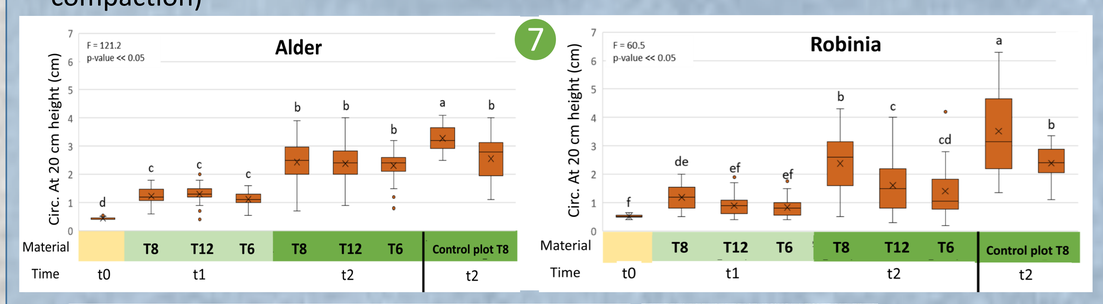
- No significant differences observed along the soil profile (n=6 per barplot),
- Heterogeneity of organic pollutants concentrations,
- Stabilization of inorganic pollutant over time,
- No significant evolution of organic pollutants : no highlighting of decomposition by natural and/or rhizodegradation (=> sample heterogenity over time and long process expected),
- No transfer observed in the soil water compartment.

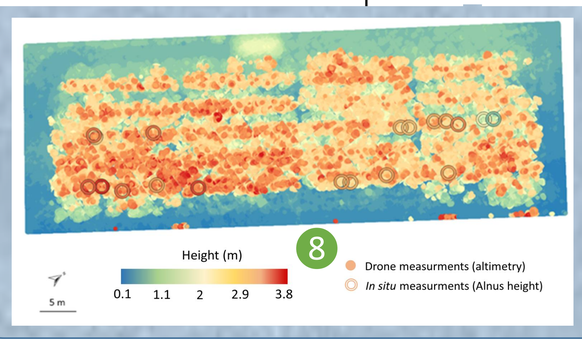
Ecosystem productivity and quality:

- Plant growth and performance (7 8 9):

- At the end of the experiment: 1.5 tonnes of raw material harvested (all leaves and woody species combined), i.e. 10 t_{WM}/ha, after two years of growth (=> lower than usually observed in short rotation coppice: climatic and competition issues)
- Growth heterogeneity between species.: Alder biomass > Locust biomass (=> Climatic and competition issues)
- Spatial heterogeneity in the development of the vegetation as a whole (=> slope, soil compaction)








Biomass before harvest, october 2021 (Image: Ginger Burgeap)

Harvested biomass (Alder), november 2021 (Image: Ginger Burgeap)

- Biomass quality:
  - High biomass humidity requiring drying prior to its energy recovery
  - Lower calorific value of dry biomass: 17.7 to 18.6 MJ/kg for each of the samples (NF EN ISO 18125) (Common value),
  - Dry biomass contains 3-5% of mineral matter (ash content) (higher than the ash levels generally observed in biomass),
  - Relatively low nitrogen and sulfur content favorable indicators of smoke quality of combustion with respect to the production of NOx and SOx (NF EN ISO 16948, 16994, internal methodology SOCOR PA334)
  - Total content of regulated inorganic elements << regulated threshold (NF EN ISO 16967).
  - The results of combustion tests (smoke and ash) are being analyzed.

Take home message

This demonstrator in real conditions reveals pollution control in the different compartments, without identifying transfer and highlighting the phytostabilization. It also testifies to a production model that does not deplete the resource, particularly soil nutrients.
The results of the analyzes of the aerial biomass harvested point a potential recovery in energy wood production for a local supply chain, given their compliance with the thresholds of the French Biomass Decree (03/08/2018).

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