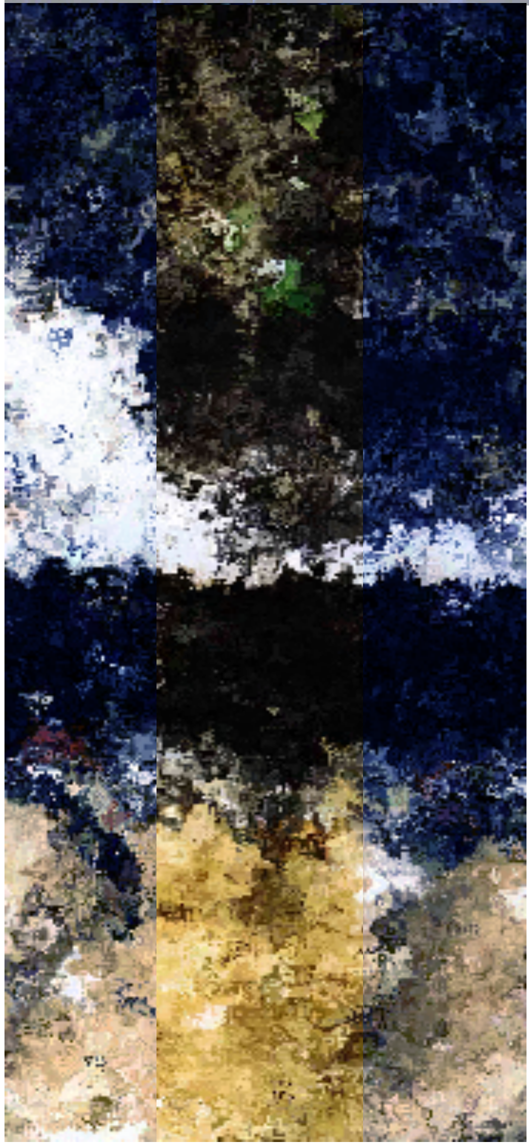

Long-term assessment of natural attenuation: statistical approach on soils with aged PAH-contamination

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Introduction

- Natural attenuation is often presented by polluted land owners as an ideal remediation technique for derelict and polluted lands combining revegetation and minimal management and cost.
- But authorities remain skeptic, regulations mostly ignoring this approach.
- Indeed, natural attenuation often sounds to them as “do nothing; nature will take rid of the problem”.

Introduction

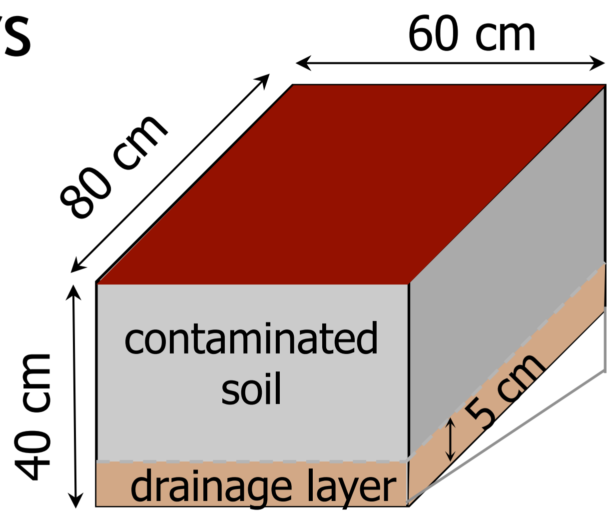
- This attitude comes from both the lack of studies to really assess the efficiency and threats of this practice but also from its apparent absence of cost for polluters that could seem immoral and against public expectations.

Introduction

- The present work proposes a long term evaluation of natural attenuation for management of PAH contaminated soils from different former industrial sites (coking industry, manufactured gas plants).
- An impact diagnosis was performed on sixty off-ground plots that were left to natural attenuation for more than ten years.

Materials and devices

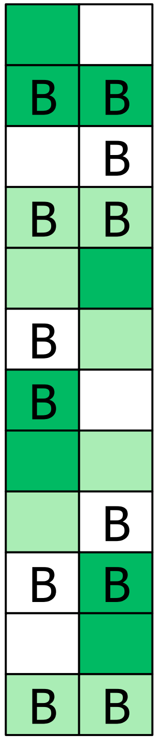
- 60 PVC lysimeters
- 3 contaminated soils
  from former industrial sites
- variable initial surface management
- followed by nine to seven years
  natural attenuation



Sampling & Analysis

- soil and leachate sampling
  in March 2008
- vegetation determination
- pH, PAH and water analysis
- statistical analysis of data: PCA

The three materials: material 1



Material 1 coking factory	
Sand (%)	75
Silt (%)	19
Clay (%)	6
pH	8.8
CEC (cmol/kg)	9.0
C organic (%)	6.79
C/N	38
Zn (mg/kg)	1340
PAH (mg/kg)	380

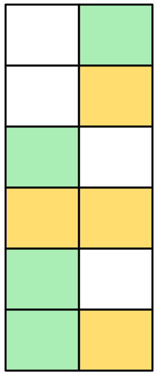
bare soil

Noccæa cærulescens

rape

B sludge amendement

The three materials: material 2



Material 2 coking factory	
Sand (%)	51
Silt (%)	38
Clay (%)	11
pH	8.1
CEC (cmol/kg)	13.0
C organic (%)	6.32
C/N	27
Zn (mg/kg)	2849
PAH (mg/kg)	2077

bare soil
rye grass
aerated soil

The three materials: material 3

	RR
A	
RR	R
R	RR
R	A
RR	R
R	A
	A
RR	
A	RR
R	A

- bare soil
R rye grass
A alfalfa
RR rye grass + red clover

Material 3 manufactured gasworks		
	3a	3b
Sand (%)	55	68
Silt (%)	24	21
Clay (%)	21	11
pH	8.2	10.4
CEC (cmol/kg)	10.8	8.3
C organic (%)	4.38	5.14
C/N	33	42
Zn (mg/kg)	127	226
PAH (mg/kg)	841	1422

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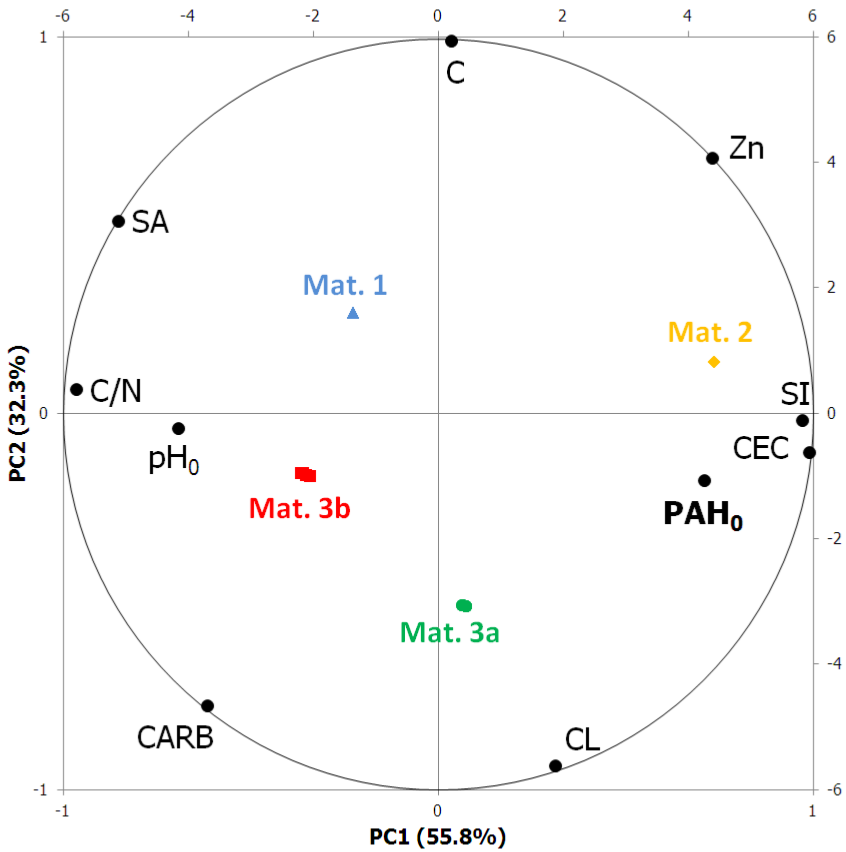
Initial time analysis

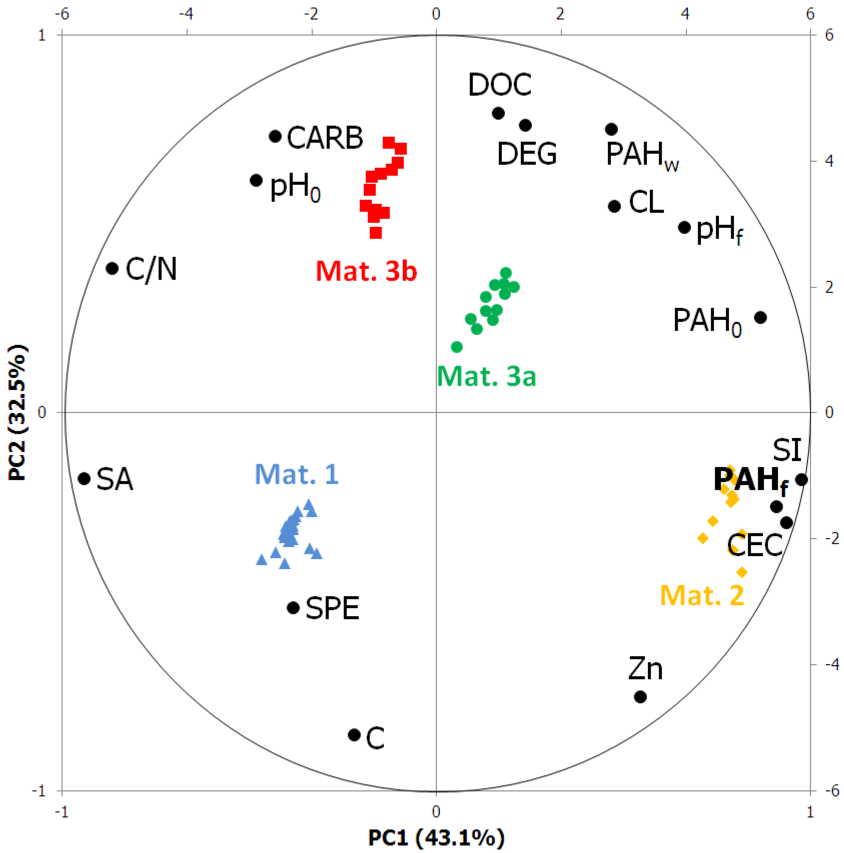
- correlation of initial PAH concentration
  with silt and CEC

- different materials
  are evenly distributed
  in projection plan



Final time analysis

- final PAH concentration well explained and linked to CEC and silt content
- plant diversity (SPE) is not controlled by soil properties or contamination
- degradation rate (DEG) linked to DOC and PAH in leached water
- PAH concentration in leached water were rather low and correlated to DOC



Global treatment performances

- up to 73% dissipation of PAH
- lowest performance obtained
  for lowest initial PAH concentration
  - possible effect of lower availability due to previous ageing
- tendency to highest vegetation diversity
  for lowest PAH concentration
  - residual toxic effect or heritage of management practices

Material	Initial PAH (mg/kg)	Final PAH (mg/kg)	PAH dissipation yield (%)	Average PAH $_w$ (µg/L)	Number plant species av. (min-max)
1	380	276	27	28±7	10.2 (4-17)**
2	2077	1631	21	67±9	6.8 (2-13)
3a	841	477	43	61±7	6.8 (5-10)
3b	1422	386	73	90±22	5.8 (3-9)

** statistical difference, p = 0.05, Kruskal - Wallis

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Conclusion

- These results clearly promote natural attenuation as a performing technique for contaminated soil remediation and management.
- Best degradation results were obtained for highest initial concentrations and seemed to be improved by liming and low silt and CEC values.
- Fine fractions appeared as central in explaining these soil reactivity and should be looked at more closely.

Conclusion

- Though dense on all materials, vegetation cover diversity still seemed negatively affected by initial PAH concentration.
- Long-term studies such as this one are still necessary to confirm these results and incite stakeholders to consider this technique as a realistic treatment alternative.

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