

SUITMA 10 | Seoul - Korea | June 2019

# Characterization of Soil Biodiversity hosted in Abandoned and Revegetated REEs Mine Sites In Southern China

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Joint laboratory LIA Ecoland (*Ecosystem services provided by contaminated Land*)

REEs : Rare Earth Elements



Joint Laboratory (LIA)  
ECOLAND



LABORATOIRE SOLS  
& ENVIRONNEMENT



中山大學  
SUN YAT-SEN UNIVERSITY



# CONTEXT & OBJECTIVES of the PROJECT



Important **ecosystems degradation** by mining activities (Kynicky *et al.*, 2012; Li *et al.*, 2014; Zhao *et al.*, 2015; Murguia *et al.*, 2016).



A growing concern regarding the **decline of biodiversity** as threat for worldwide ecosystems (UN Report - Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services *IPBES*, 2019).



Relatively small number of ecological studies dealing with the **effect of REEs on soil biota in China** (Li *et al.*, 2010; Chao *et al.*, 2016).



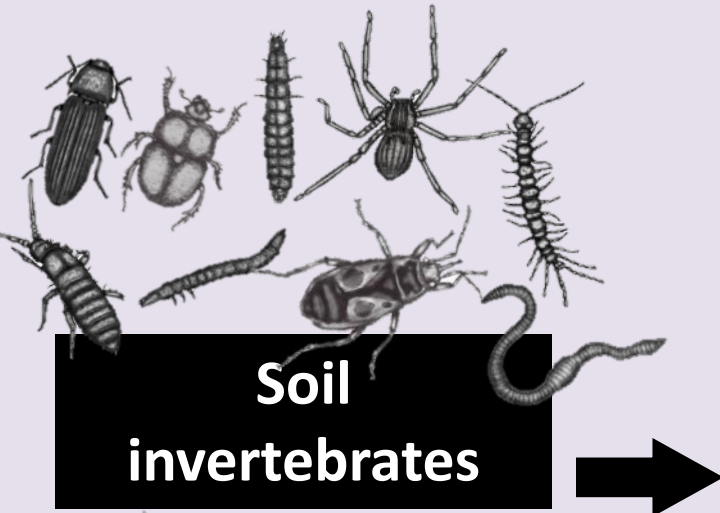
Need to investigate :

- **how biodiversity could be preserved** by understanding its adaptation in (abandoned) mine sites in order to help the development of effective and sustainable scenarii of mining ecosystem restoration.
- **how biodiversity answer to** mining ecosystem restoration after revegetation



# CONTEXT : Why studying soil biodiversity?

High functional diversity and supplying of services



**Functional processes**

**Regulation**

**Degradation & Mineralization**

**Soil structuration**

**Interactions with plants and micro-organisms**

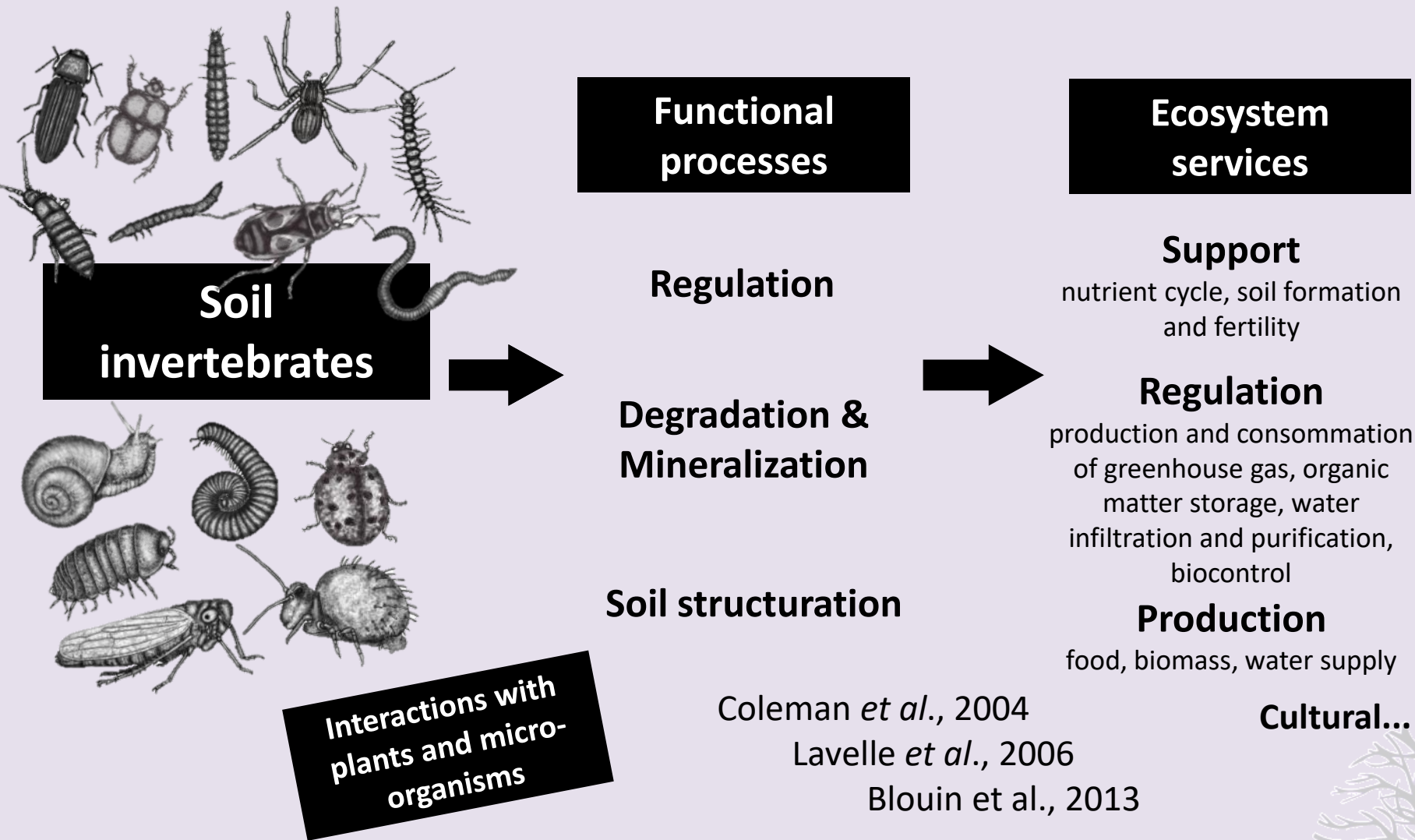
Coleman *et al.*, 2004

Lavelle *et al.*, 2006

Blouin *et al.*, 2013

# CONTEXT : Why studying soil biodiversity?

High functional diversity and supplying of services





# METHODS



Characterization of the **soil invertebrates** (meso- and macrofauna) communities in abandoned REEs mine sites and under vegetation remediation scenarii.



Determination of the **major environmental drivers** for soil taxa in mine sites by quantifying soil cover and abiotic soil parameters that evolve over time (fertility, pollution, bioavailability, physical properties).

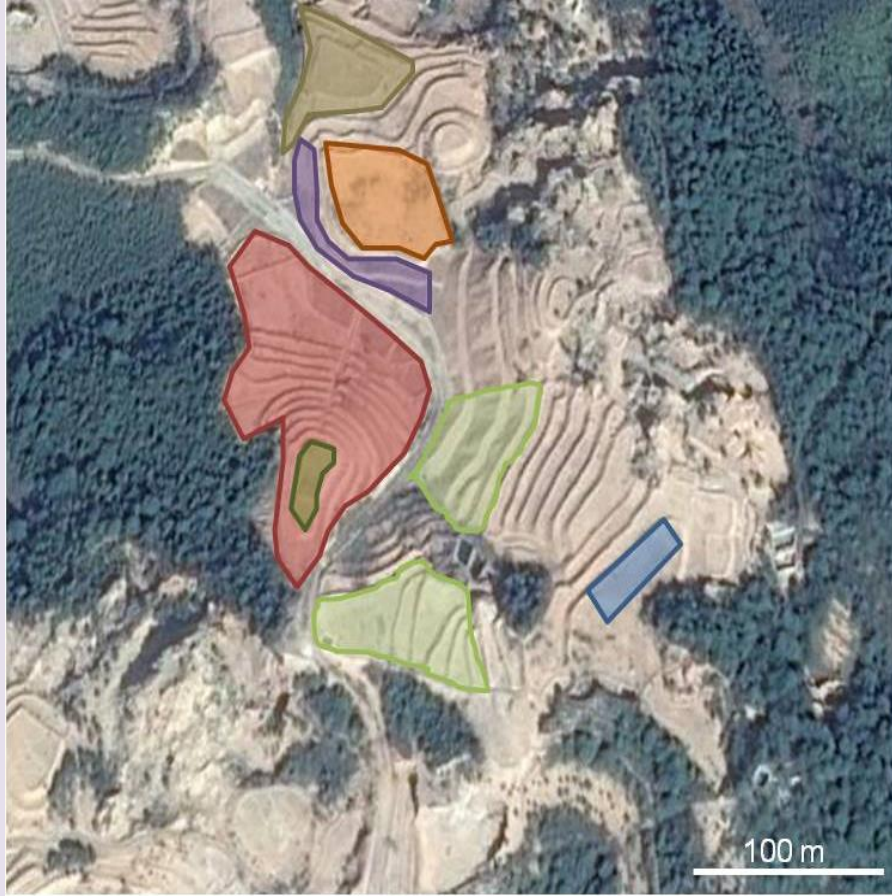






Investigation of the **roles of soil organisms** in the functioning of ecosystems developing on mine sites / study of the influence of organism activity (ecosystem engineer) on soil functions (structure development, organic matter dynamics, nutrient or pollutant cycling).



# METHODS

## Soil biota communities in REEs mine sites under different vegetation remediation scenarii (China)

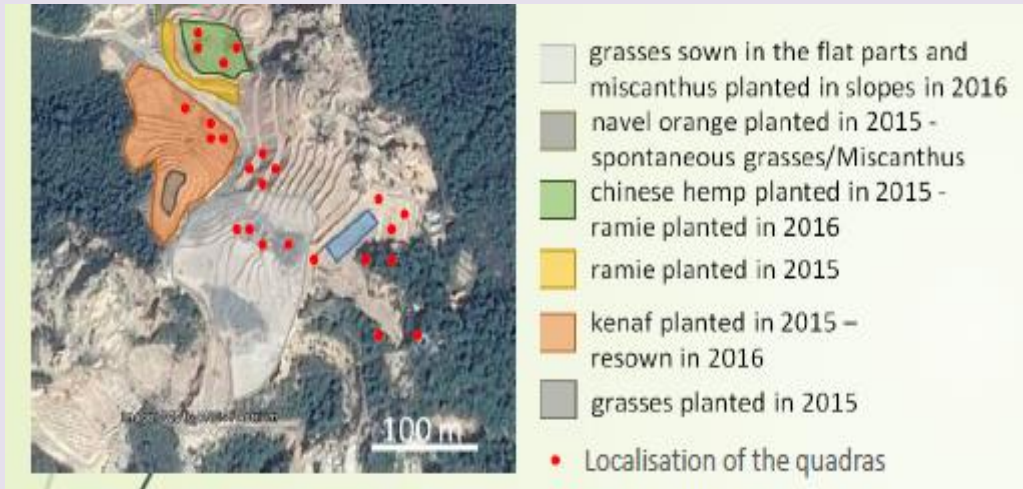


-  grasses (commercial seeds) sown and Miscanthus planted in the steep slopes and grasses sown on the terraces in 2016
-  navel orange and oil-tea trees planted and grasses (commercial seeds) sown in 2015
-  chinese hemp planted in 2015  
ramie planted in 2016 –
-  ramie planted in 2015
-  kenaf planted in 2015 – resown in 2016
-  grasses (commercial seeds) sown in 2015



# METHODS

## *Soil biota communities in REEs mine sites under different vegetation remediation scenarii (China) – sampling in 2017*



### Studied plant cover:

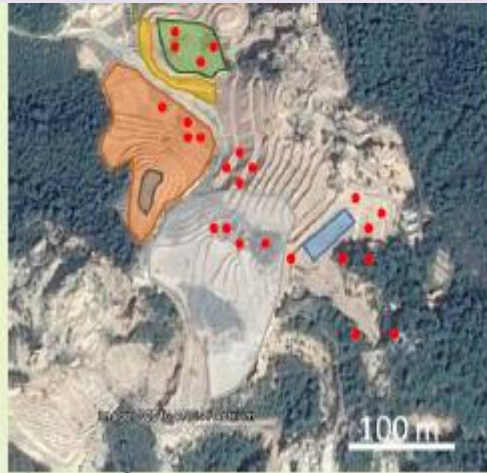
- grasses
- grasses + *Miscanthus sinensis*
- ramie (*Boehmeria nivea*)
- kenaf (*Hibiscus cannabinus*)
  
- bare soil
- native plant cover (forest)

Auclerc et al., in prep

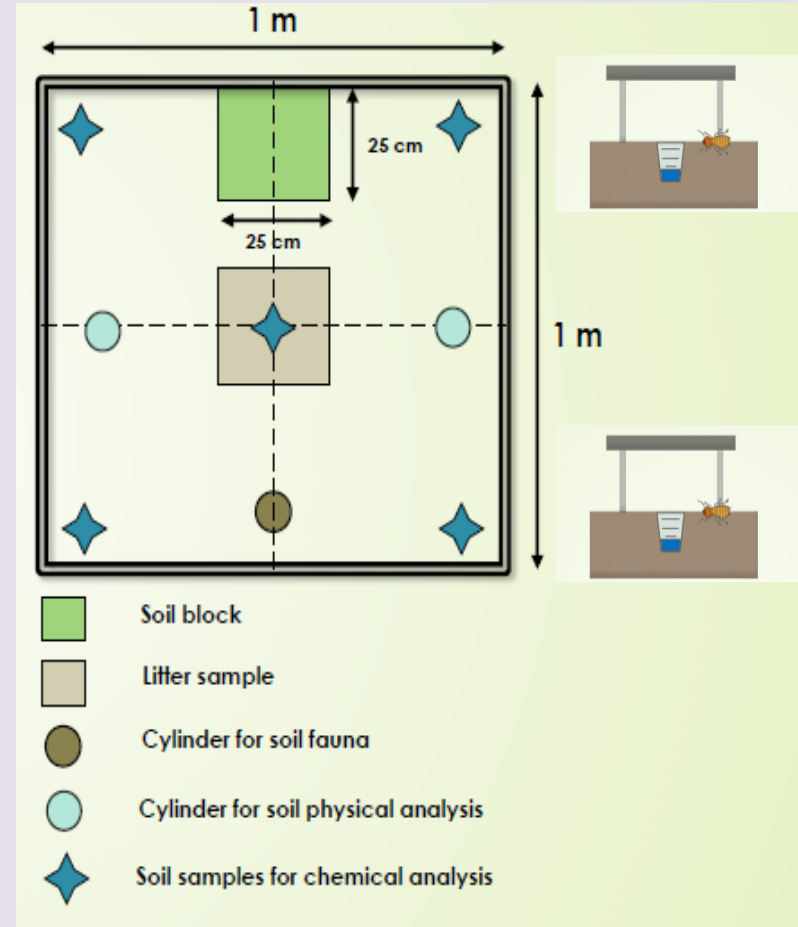


# METHODS

## Soil biota communities in REEs mine sites under different vegetation remediation scenarii (China) – sampling in 2017



- grasses sown in the flat parts and miscanthus planted in slopes in 2016
- navel orange planted in 2015 - spontaneous grasses/Miscanthus
- chinese hemp planted in 2015 - ramie planted in 2016
- ramie planted in 2015
- kenaf planted in 2015 – resown in 2016
- grasses planted in 2015
- Localisation of the quadrats



### Studied soil fauna communities for one given plot :

- surface (mobile) N=8
- litter and soil (less mobile) N=4

### Studied plant cover:

- grasses
- grasses + *Miscanthus sinensis*
- ramie (*Boehmeria nivea*)
- kenaf (*Hibiscus cannabinus*)
- bare soil
- native plant cover (forest)

+ soil chemistry & physic

Auclerc et al., in prep



# METHODS

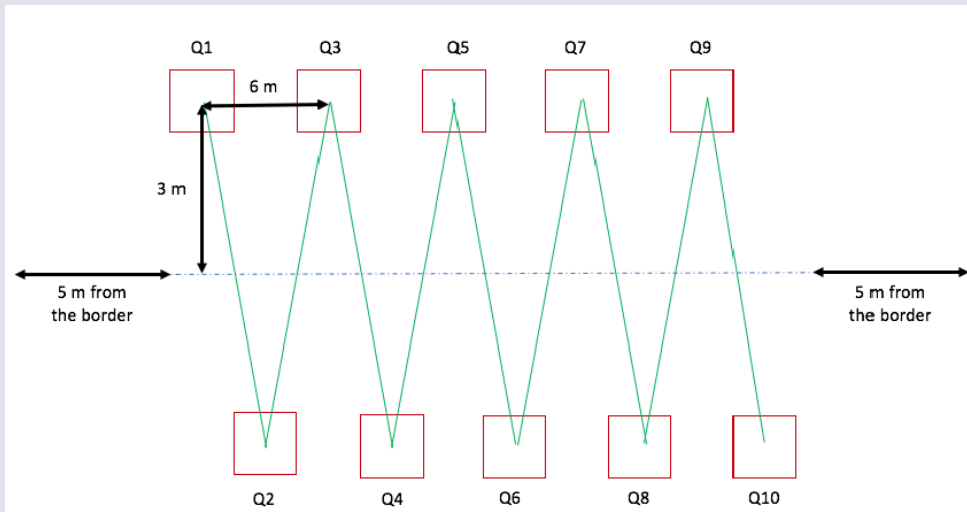
## Soil biota communities in abandoned REEs mine sites – sampling in 2018



4 abandoned mine sites + 3 native forest sites

# METHODS

## *Soil biota communities in abandoned REEs mine sites – sampling in 2018*



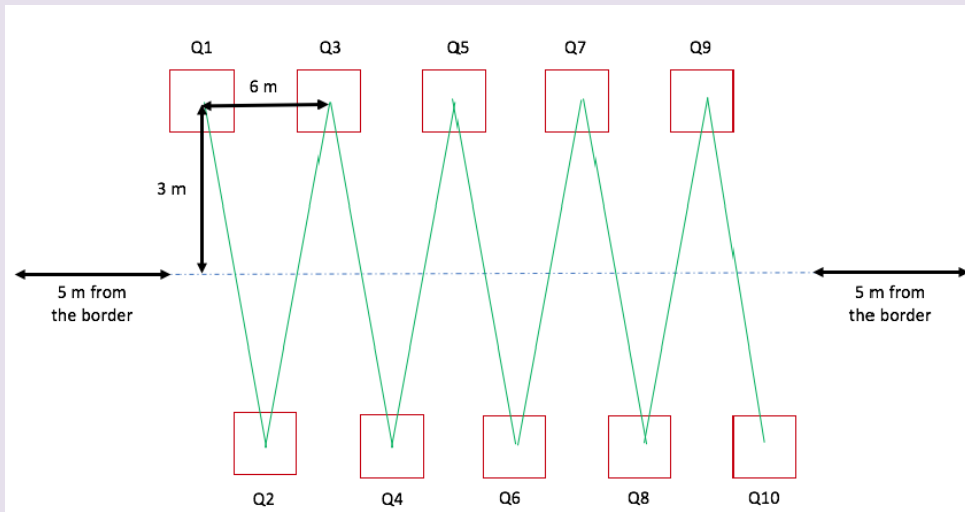
N = 10 for abandoned sites (15 / 11 / 7 yrs)

N = 4+3+3 for the 3 control plots (native forest)



# METHODS

## Soil biota communities in abandoned REEs mine sites – sampling in 2018



N = 10 for abandoned sites (15 / 11 / 7 yrs)

N = 4+3+3 for the 3 control plots (native forest)

### Studied soil fauna communities for one given plot:

- surface (mobile) N=10
- litter and soil (less mobile) N=10

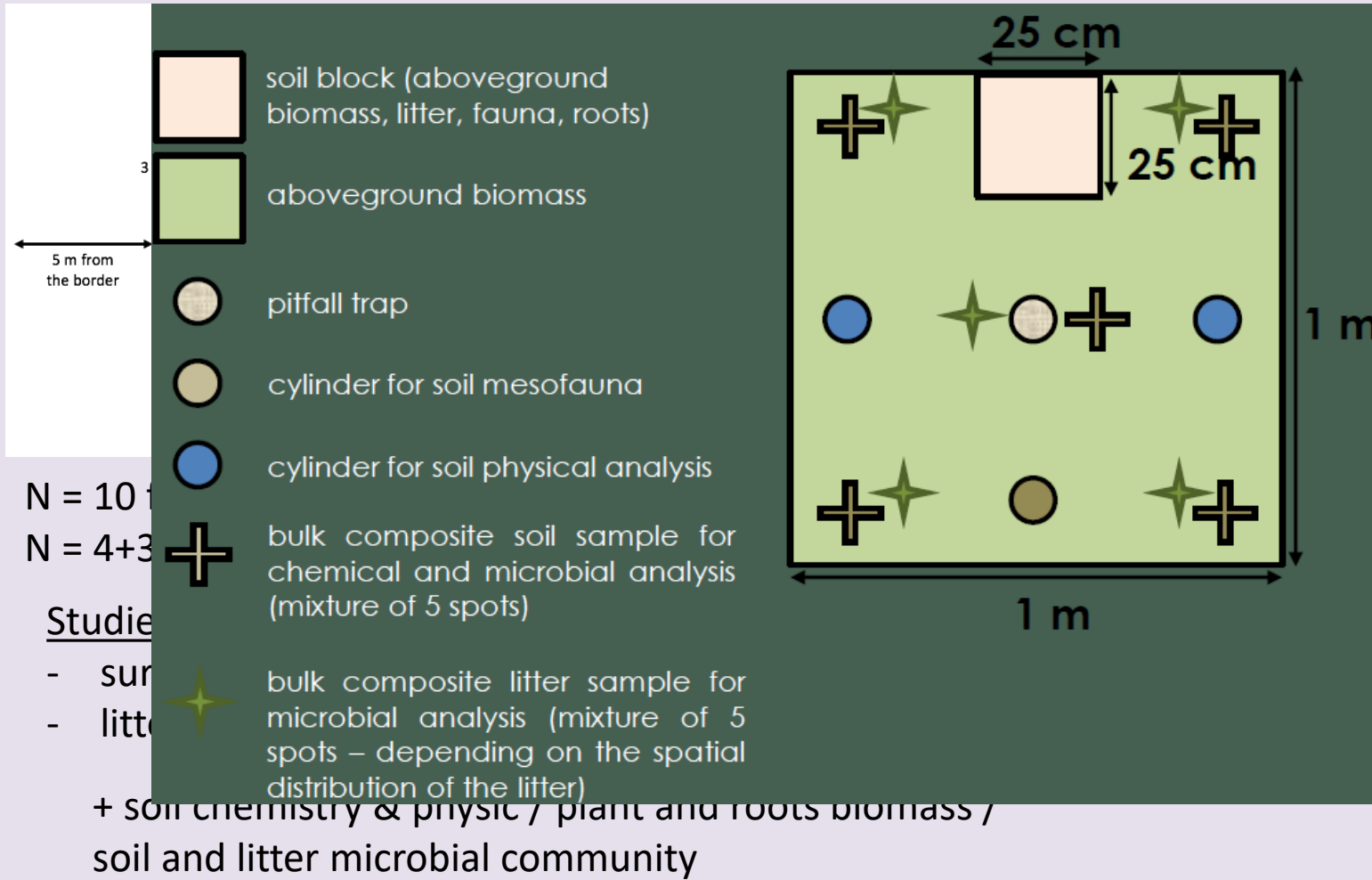
+ soil chemistry & physic / plant and roots biomass /  
soil and litter microbial community





# METHODS

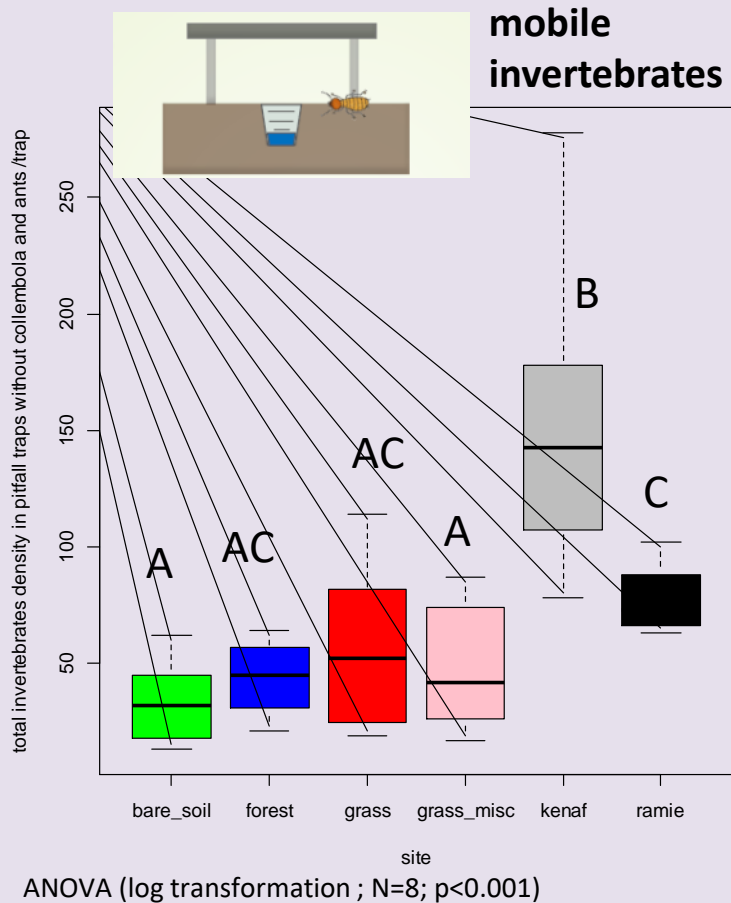
## Soil biota communities in abandoned REEs mine sites – sampling in 2018





# RESULTS

## Soil biota communities in REEs mine sites under different vegetation remediation scenarii (China) – sampling in 2017



site	Taxa richness (mean ± SD)	Shannon index (mean ± SD)
bare soil	8.375 ± 1.69 A	1.63 ± 0.23 A
forest	11.875 ± 2.03 B	2.02 ± 0.12 B
grass	12 ± 2.39 B	1.47 ± 0.26 A
grass_misc	9.375 ± 2.33 AB	1.46 ± 0.26 A
kenaf	16.25 ± 1.16 C	2.04 ± 0.18 B
ramie	15.875 ± 2.59 C	2.16 ± 0.16 B
ANOVA	P<0.001	P<0.001



There is a soil cover positive impact on soil community



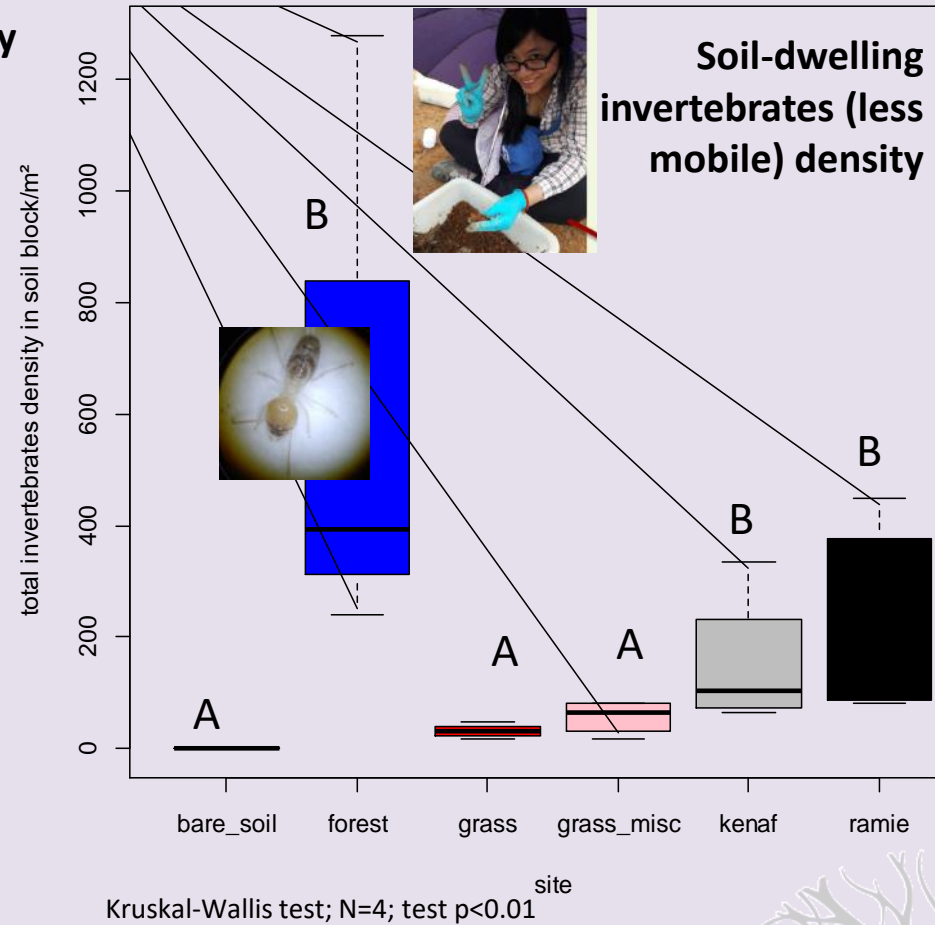
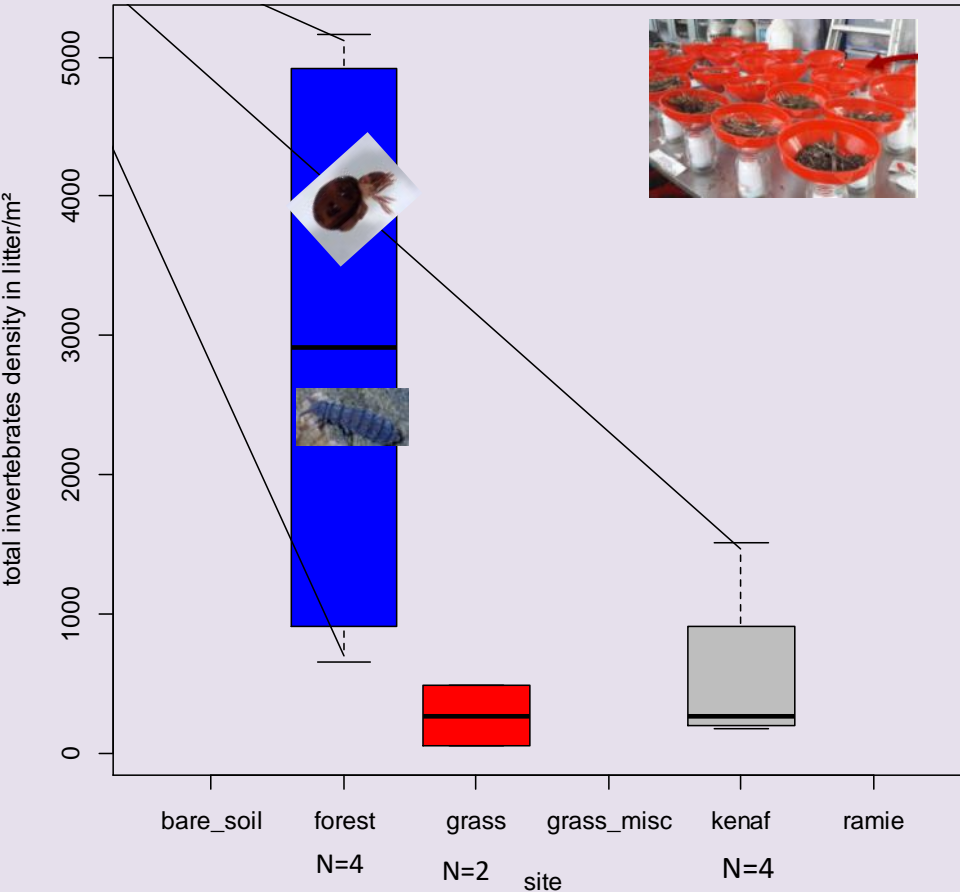
Increase of diversity and abundance thanks to rehabilitation

Auclerc *et al.*, in prep

# RESULTS

## Soil biota communities in REEs mine sites under different vegetation remediation scenarii (China) – sampling in 2017

Litter-dwelling invertebrates (less mobile) density

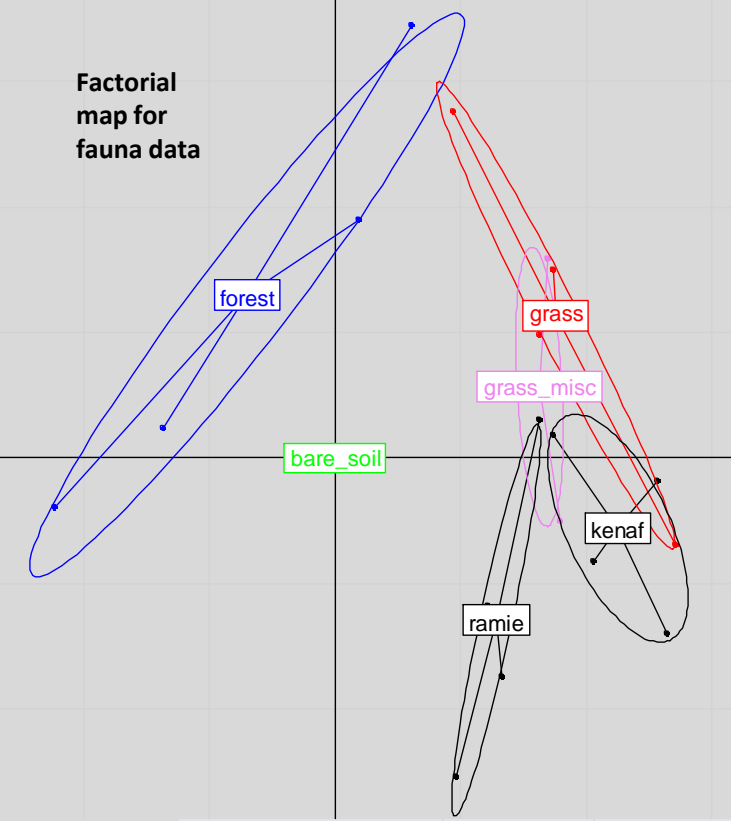
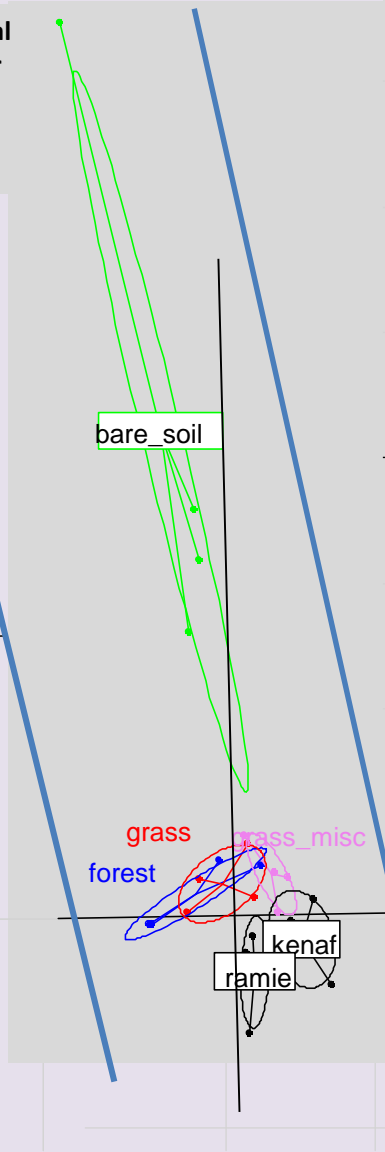
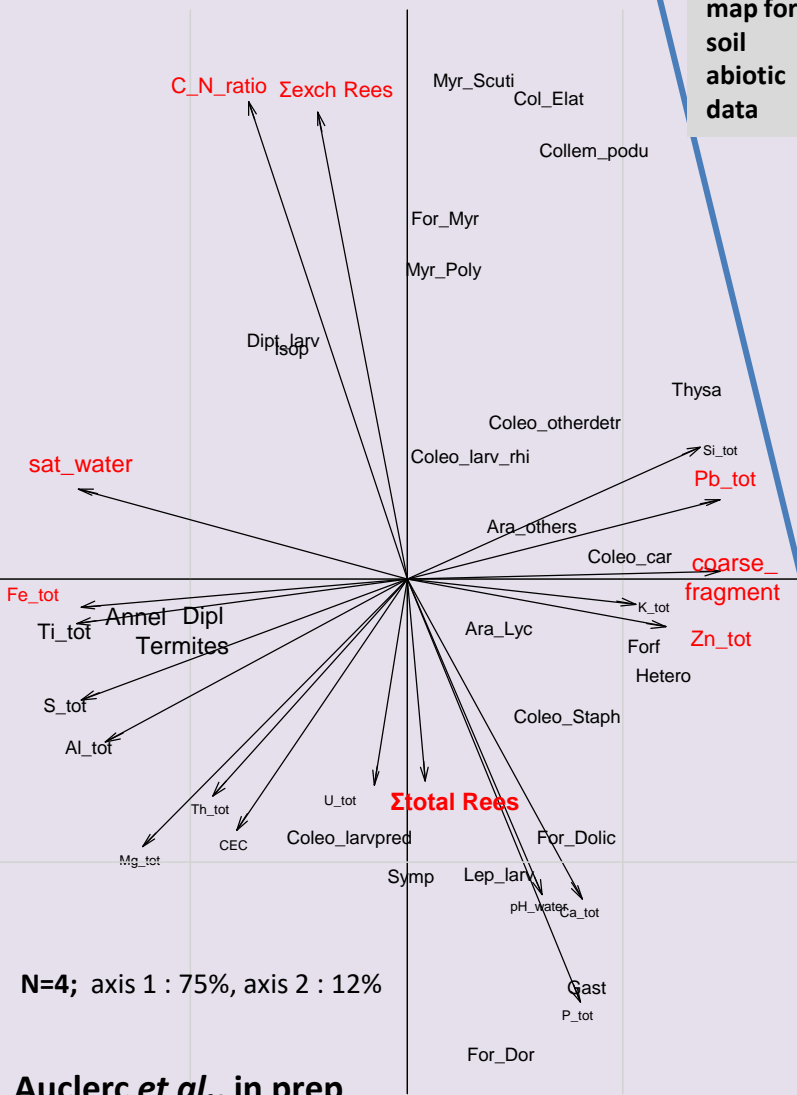


Auclerc *et al.*, in prep

There is an effect of soil cover on litter and soil dwelling-invertebrates densities

# RESULTS

## Coinertia for abiotic and biotic soil data



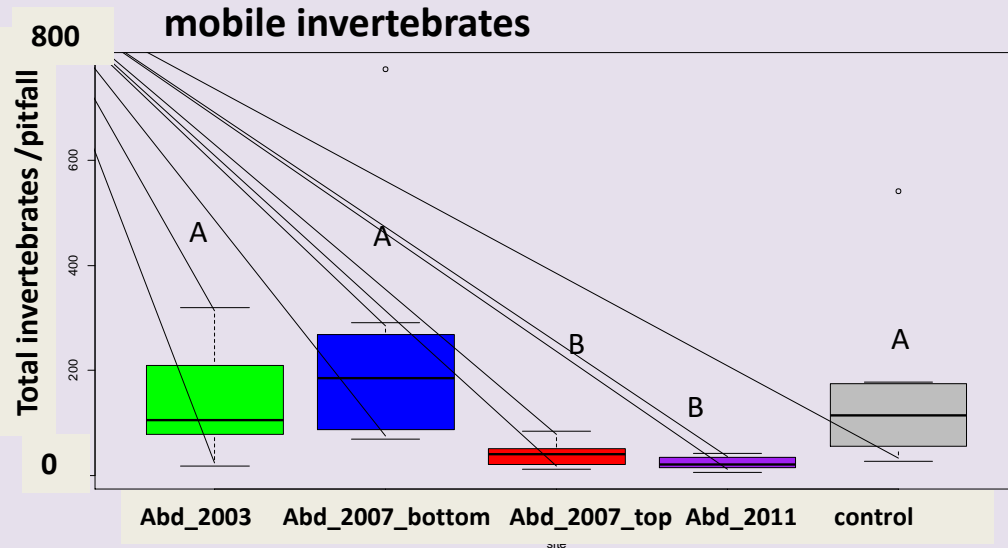
Site	Σ [total REEs] mg/kg	Σ [exch REEs] mg/kg
bare soil	710.92±165.00	15.47±9.82 A
forest	600.40±146.78	0.70±0.31 B
grass	473.43±102.30	0.85±0.34 B
grass_misc	421.55±48.85	0.63±0.66 B
kenaf	442.74±89.12	0.24±0.15 B
ramie	2395.83±2890.99	0.34±0.25 B
K-W ; N=4	P>0.05	P<0.01

Covariation between chemical soil parameters – plant cover and abundance of certain invertebrates



# RESULTS

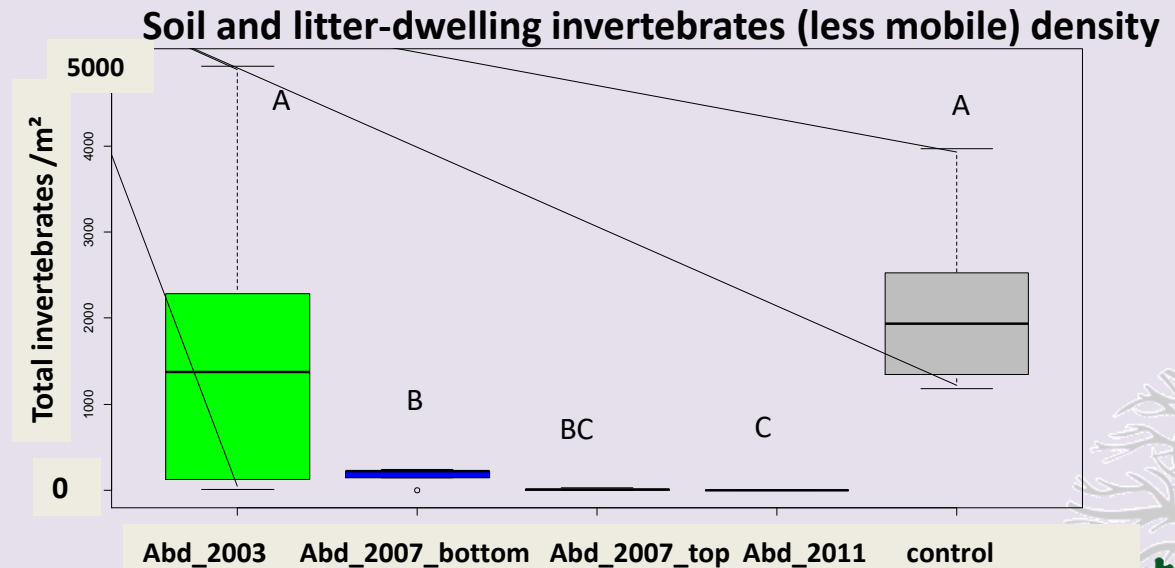
## Soil biota communities in abandoned REEs mine sites – sampling in 2018



Site	$\Sigma$ [total REEs] mg/kg	$\Sigma$ [exch REEs] mg/kg
control	558.66±169.78	1.61±0.65 A
Abandoned 2003	804.20±177.36	3.28±1.77 AB
Abandoned 2007 bottom	702.06±118.07	2.54±1.39 A
Abandoned 2007 top	1100.68±824.47	<b>14.07±19.25 B</b>
Abandoned 2011	828.78±313.85	<b>8.55±5.95 B</b>
K-W ; N=10	P>0.05	P<0.001

ANOVA ; log-transformation; N=10 ; p<0.001

There is an abandoned age effect (and surrounding landscape effect?) on the density of invertebrates








ANOVA ; log transformation; N=5 ; p<0.001





# Take home messages

-  Biodiversity is present at the soil surface (litter layer) and in soil (0-20cm) in REEs mine sites under soil cover (*values are close to the ones of French degraded soils, Vincent et al., 2018*)
-  Biodiversity can recolonize abandoned sites if biodiversity reserve are present in the landscape.
-  There is an impact of the rehabilitation scenario on chemical soil parameters and on soil biota = « selection of species »
-  Invertebrates have feedbacks on ecosystem functioning
-  We have to think to the ecosystem services they provide and then, assist organisms to recolonize soil ecosystem in restoration scenarii design (ecological engineering / sustainability)

# Thanks for your attention

## Q&A?



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## Soils within Cities

Global approaches to their sustainable management

Editors: M.J. Levin, K.-H.J. Kim, J.L. Morel, W. Burghardt,  
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## 9.2. Regulating services provided by urban soils

### 9.2.3 Biodiversity p.213-220

Auclerc, 2017



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