

A photograph of two earthworms on a bed of green moss and grass. One worm is dark brown and the other is lighter, pinkish-brown. They are both curved across the frame.

# Earthworms as actors and indicators: investigation from laboratory to field scale

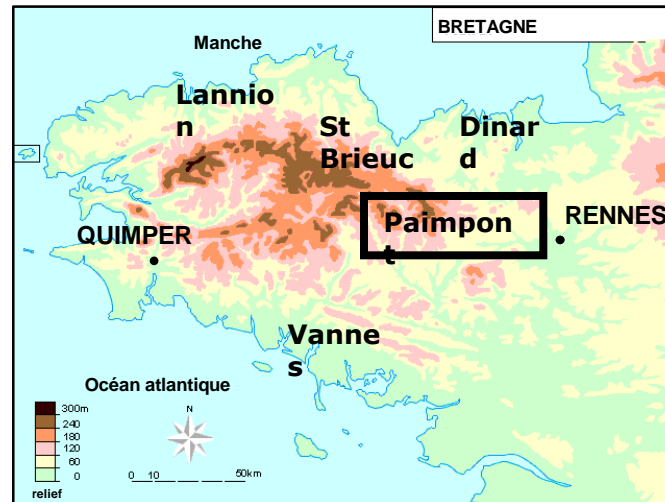
Pérès Guénola

UMR 6553 *EcoBio*,  
CNRS -Rennes 1 University,

## □ General characteristics



- 25 000 students
- 1620 professor-searchers, researchers
- 940 engineers, technicians, administratifs



Experimental station of Paimpont

## □ Organisation

Structuration in Mixe Research Units (UMR)



**Daniel Cluzeau**



**Hoel Hotte**  
(sampling manager)



**Muriel Guernion**  
(data treatment)

**Charlène Briard**  
(PhD. phyllogeny)

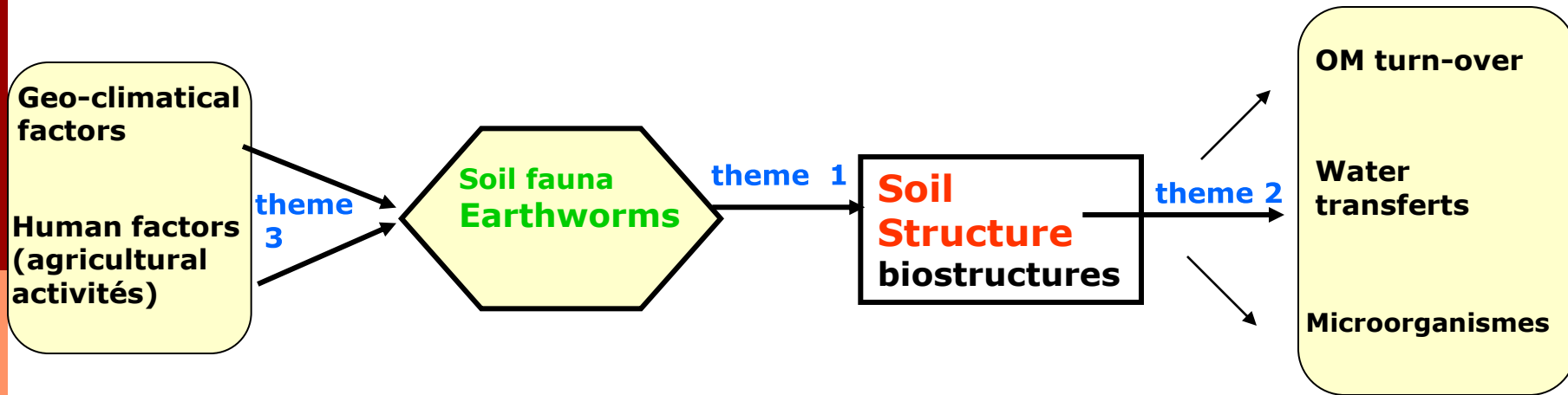
**Antoine Dewisne**  
(Agroforestry)

**Guénola Pérès**



**Denis Piron**  
(soil bioturbation)

# Three general research themes



**T1** : how does soil fauna influence the soil structure ?

→ State of **actor**

**T2** : how do biostructures influence soil functioning ?

**T3** : how is soil fauna influenced by the agrosystems conditions and geo-climatical conditions ?

→ State of **indicator** played by the fauna

→ Phylogeography aspect

## Some of our questions

### 1) Ecological Function : soil structuration

Q1 : Could we link pore typology to some earthworm groups ?

Q2 : Is there a relation between earthworm density and burrow density ?

Q3 : Could we characterize earthworm burrow network  
-> specific functional traits ?

### 2) Ecological Function :

Q4: Which parameters influence soil water movement in soil ?

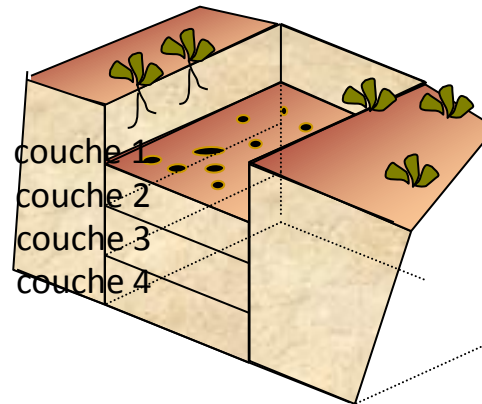
Q5: What about C transfert

## Q1 : Link between pore typology and earthworm group ?

### Methodology



1) Earthworm sampling (1m<sup>2</sup>)



2) Excavation of the different horizons (25 X 25 cm)



3) Identification of burrows



5) Quantification & characterisation of the macropores

density approach  
(directly in situ)

morphological approach in 2D  
(image analysis)

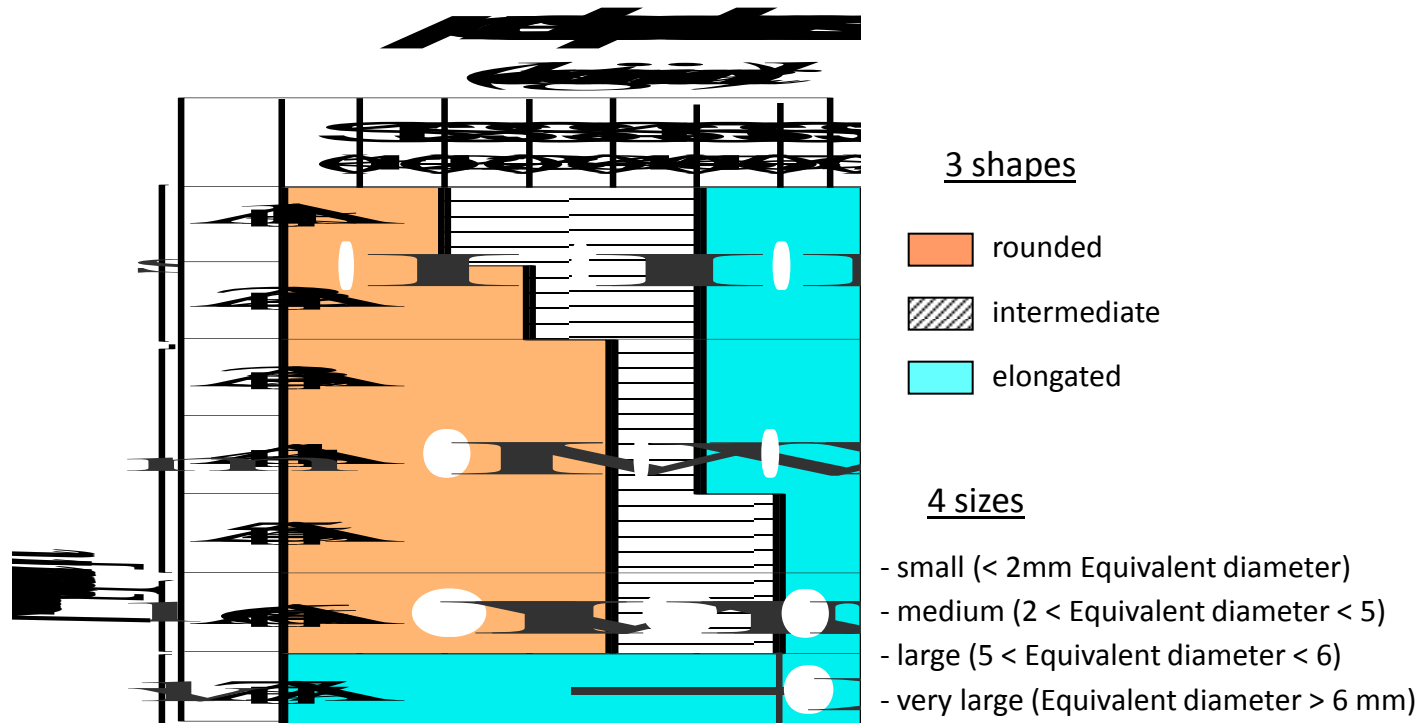


4) Distinction of the burrows  
- Shape typology: round, long, intermediate  
- Size typology : small, medium, long, very long



## Q1 : Link between pore typology and earthworm group ?

### Result



❖ Definition of a typology of macropores (10 classes)

➔ specific link between the pores classes and earthworms groups

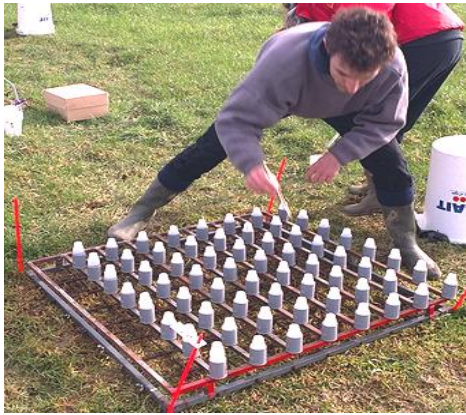
(crossing ecological categories and growth stages)

(example : classe VII = anecic adults)

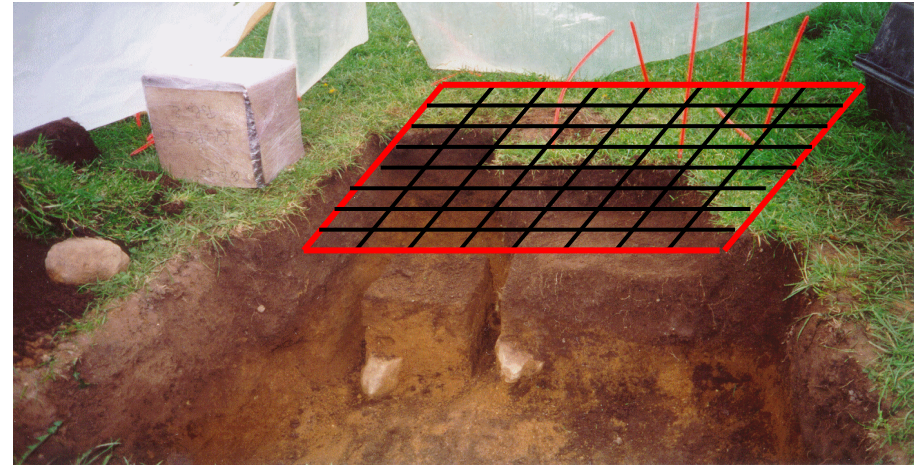
(Pérès et al., 1998)

## Q2: Relation between earthworms and macroporosity (burrows) observed on soil profile *in situ* ?

### Methodology



1) Earthworm sampling (1m<sup>2</sup>)



2) Excavation of the different horizons (25 X 25 cm)



4) Quantification of the burrows

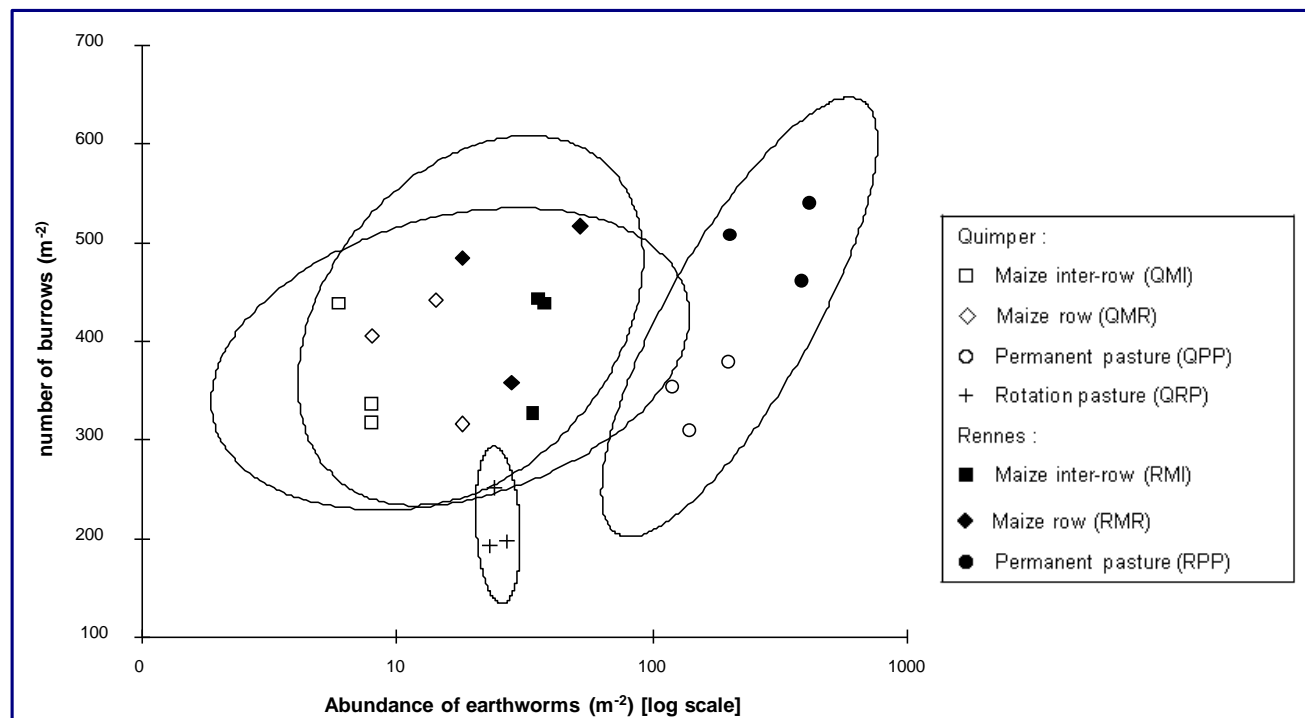


3) Identification of burrows



## Q2: Relation between earthworms and macroporosity (burrows) observed on soil profile *in situ* ?

### Results



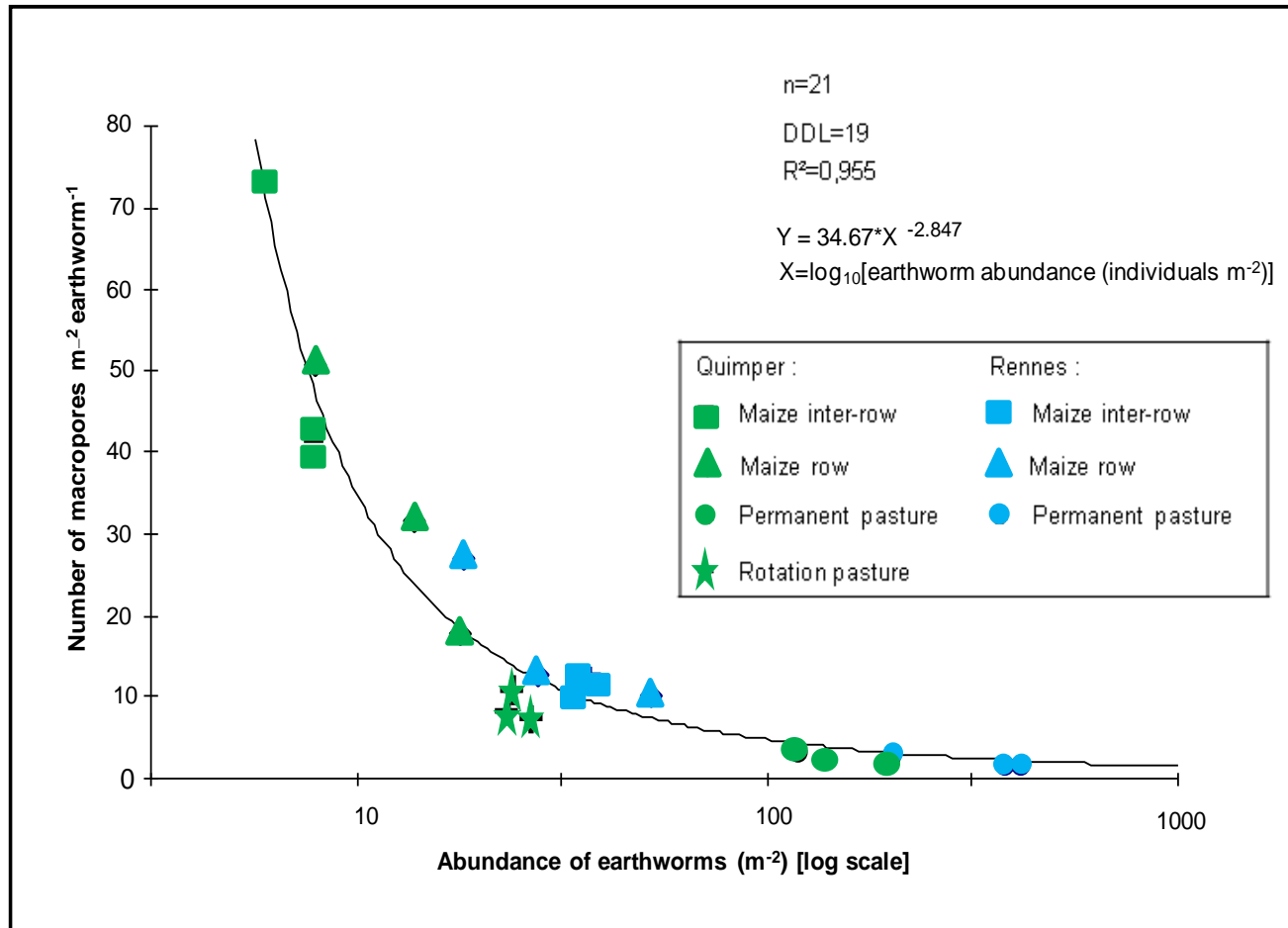
No relationships between earthworm density (m<sup>2</sup>) and burrow number (m<sup>2</sup>)

❖ Strong influence of the agricultural practices (organic matter return)  
→ Modification of the foraging activity in relation with the food search

❖ Strong influence of the specific communities  
→ Confirmation of the highest foraging activity of *Aporrectodea / Lumbricus*

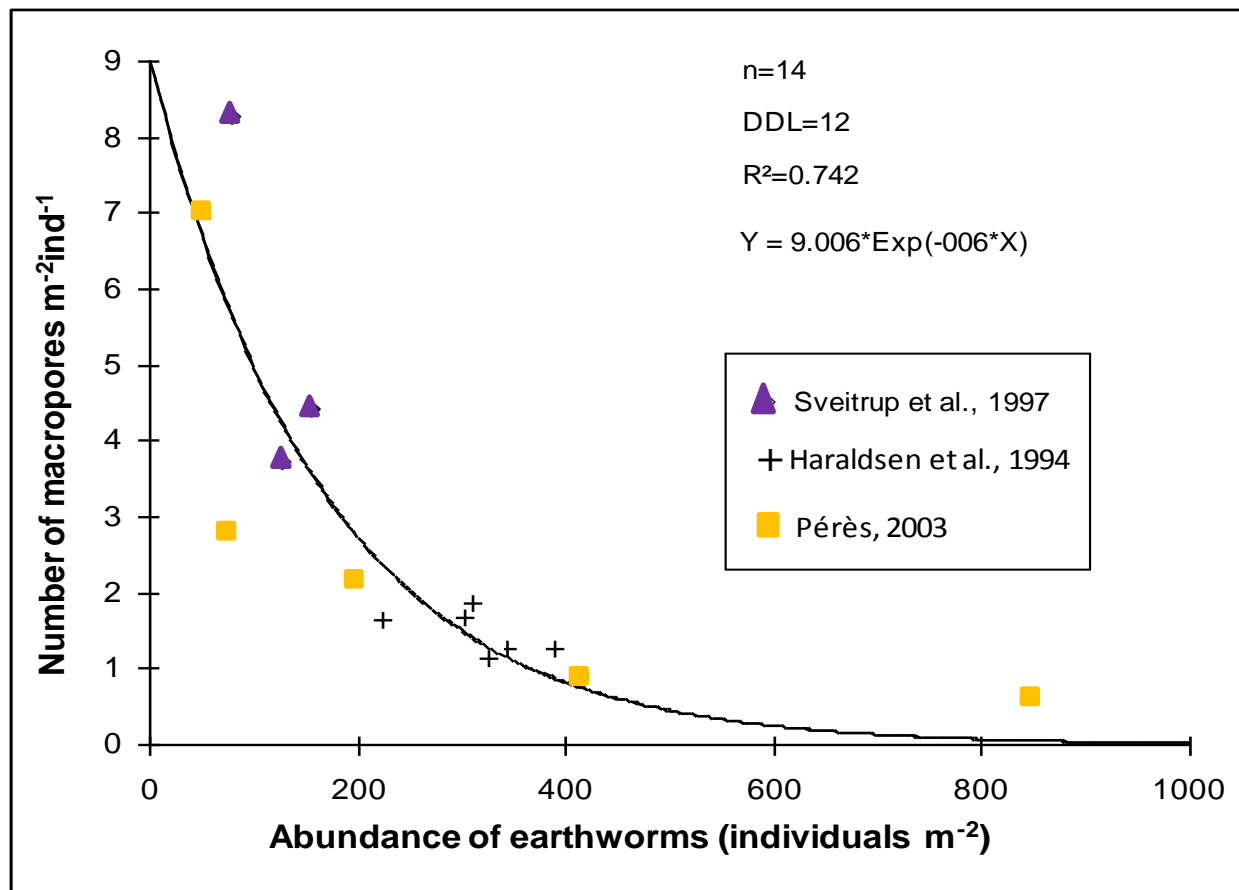
## Q2: Relation between earthworms and macroporosity (burrows) observed on soil profile *in situ* ?

### Results



## Q2: Relation between earthworms and macroporosity (burrows) observed on soil profile in situ ?

### Results





## Q4: Which parameters influence soil water movement in soil ?

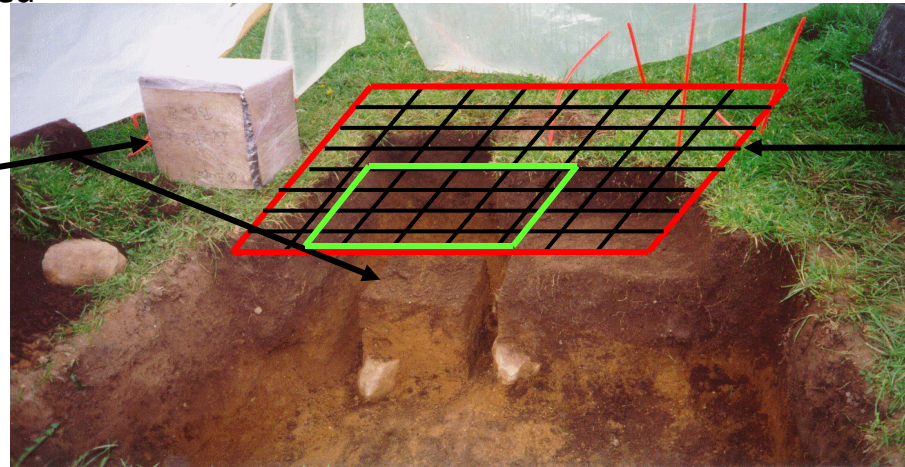
### Methodology

#### Excavation of soil block (field)

Under the earthworm sampling area

- soil block cut with knife
- soil block extracted by hand

Soil blocks  
(25 x 25 x 25 cm)



Frame for  
earthworms  
sampling

#### Preparation of soil block (laboratory)



Cut the block  
(cubic shape : 25x25x25 cm)

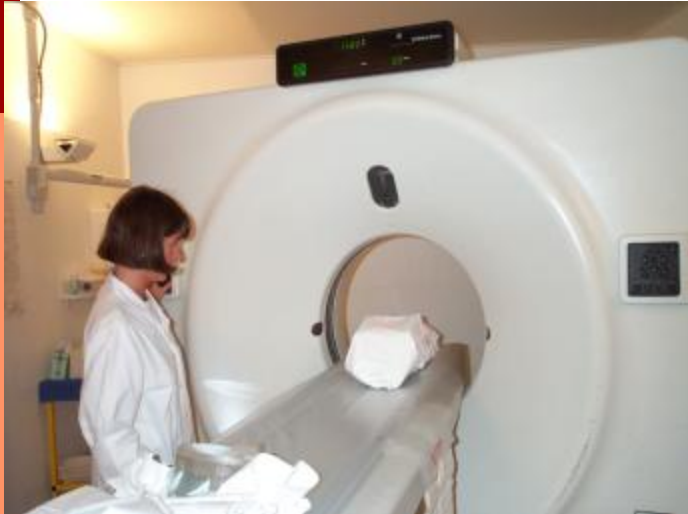


Plaster the block  
(cylindrical shape : 25 cm height x 21 cm diameter)

X ray  
tomography

## Q4: Which parameters influence soil water movement in soil ?

### Etape 1



**X ray Tomography (CHU. Pontchaillou)**



**3D reconstitution**

### Characterisation of burrows:

length, volume, pore diameter, orientation, continuity, tortuosity, branching rate

### Etape 2



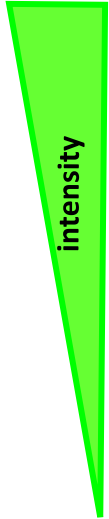
**Conductivity  
measurment (Ksat)**

# Burrows Characteristics

Water transfers  
*via* biological features  
(burrows)



Influenced by



- diameter of pore opening
- continuity of pore
- branching rate
- number of opening burrow
- Length, tortuosity

Depend on

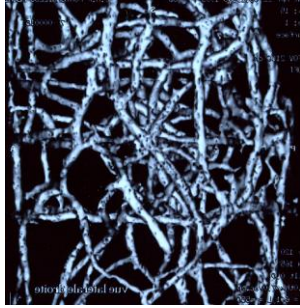
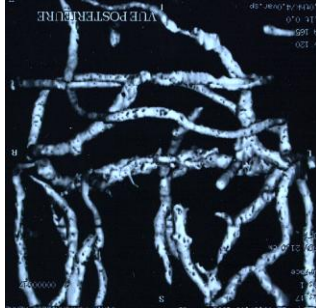
Soil surface state

Earthworm species  
& growth stage

- presence of casts on soil surface
- stability of casts (organic matter)



maintenance of the opening pore



*L. terrestris*

*A. giardi*

(Jégou, 1998)

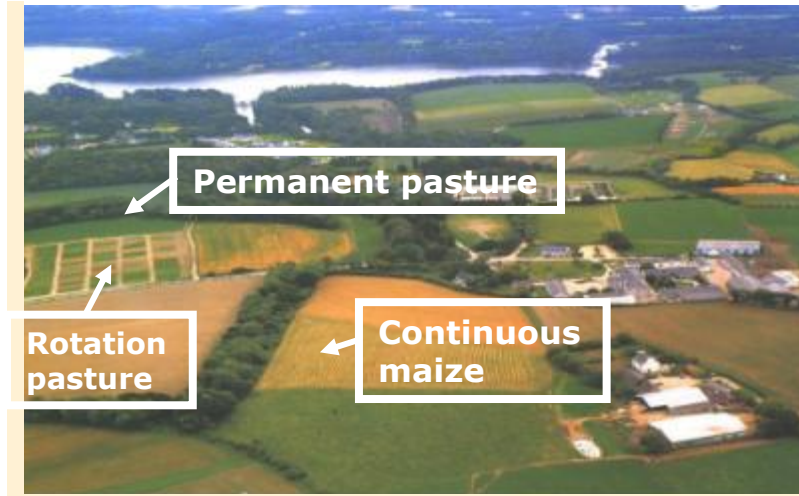


# Plan

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## Earthworms as indicators

## □ Many agro-systems



**Mixed-farming and breeding** (Brittany)



**Vineyards**  
(Champagne, Bourgogne, Beaujolais)



**Agroforestry**



**Industrial wastelands**

## □ Agricultural practices



**Tillage/ no-tillage**



**Organic managemets**



**Pesticides,  
Contamination**

**Plants diversity**



Regional scale -> Programme RMQS-Biodiv (2005-2009)

Objectif : to state and monitor soil biodiversity at regional scale (Brittany)

Large diversity assessed



macrofauna

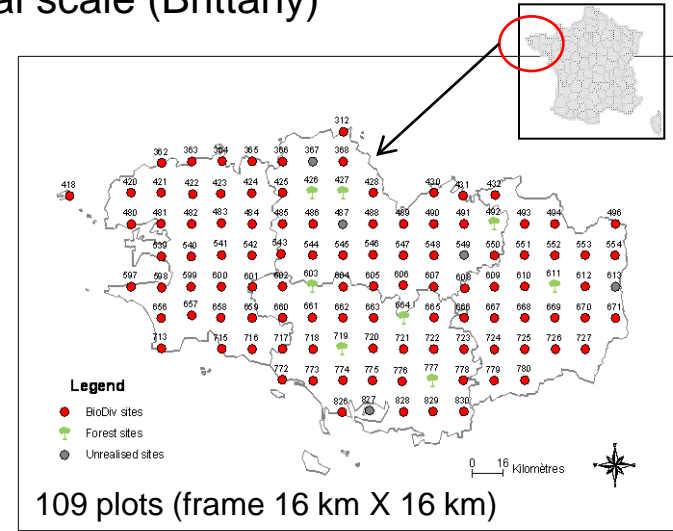


mesofauna

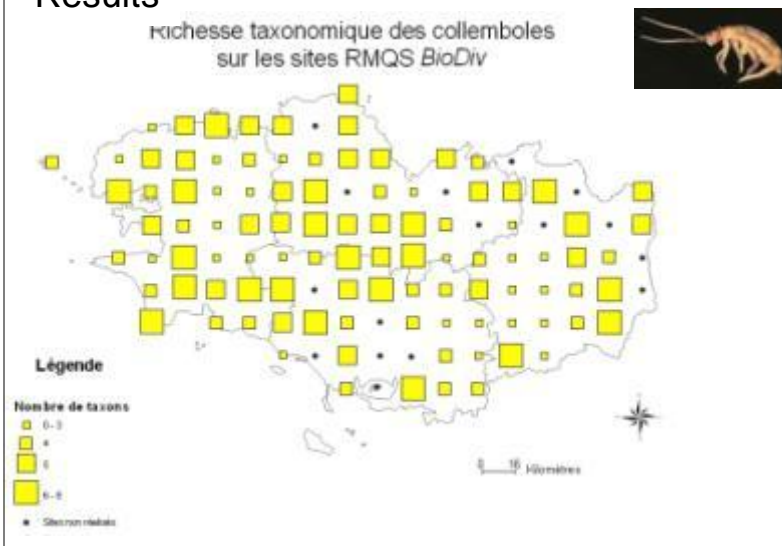


microfauna, microflora

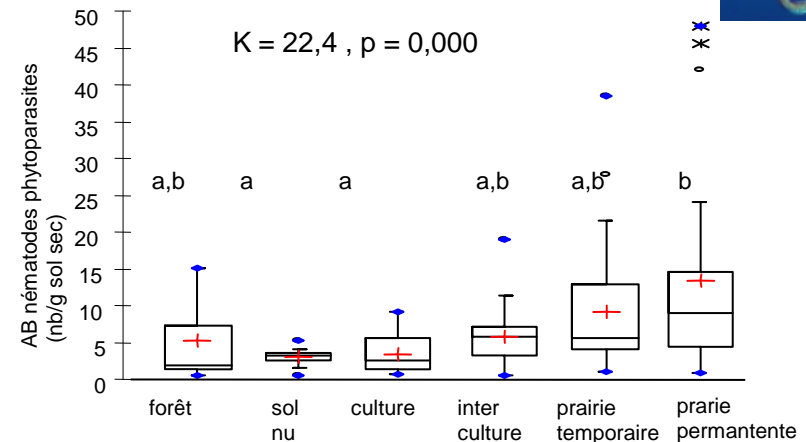
13 research team involved



Results



Impact of land uses on nematodes



(Pérès et al., 2008 ; Cluzeau et al., 2009 ; Cluzeau et al., 2011)

National scale -> Programme ADEME - Bioindicateurs (2009-2012)

Objectifs : to test and validate the relevance of bioindicator for different purposes: risk assessment, soil characterization, monitoring.

Large diversity of parameters

47 parameters



Microorganismes



Fauna  
(macro, méso, microfaune)



Flora

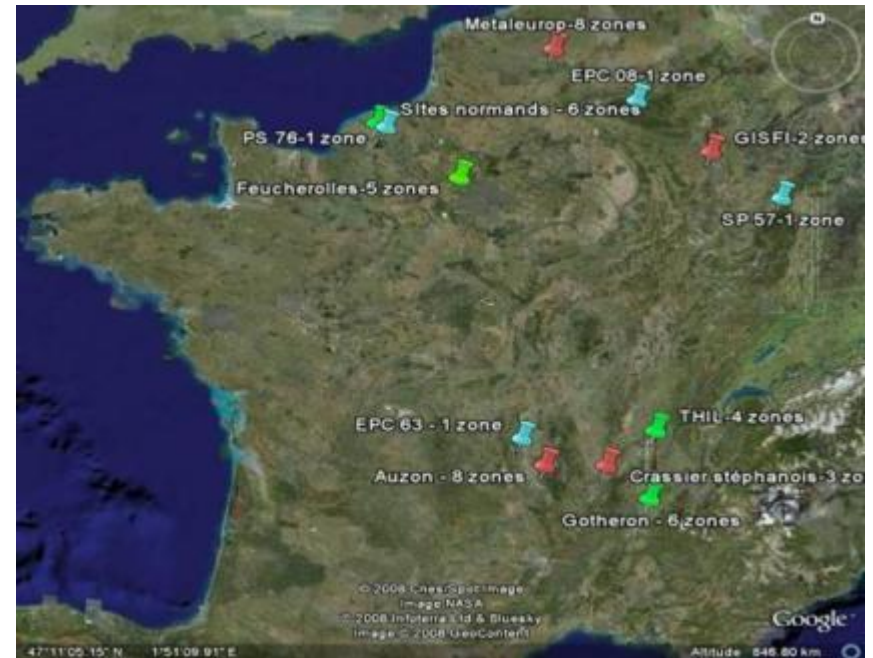
différents scales

**Communauté**  
structure

**Population**  
abondance, biomass,  
presence-absence  
structure

**Individu**  
activité enzymatique  
accumulation des ETM

Large number of sites and plots



13 sites (forest, contaminated soils, agricultural soils), 47 plots

European scale -> Programme SUSTAIN (2011-2014)

## Soil Functional Biodiversity and Ecosystem Services, a Transdisciplinary Approach

Objectifs : to quantify the biological responses in no tillage system  
to assess the consequence in terms of soil functions and ecosystem services  
to study the sustainability of this agrosystem (sociology and economy)



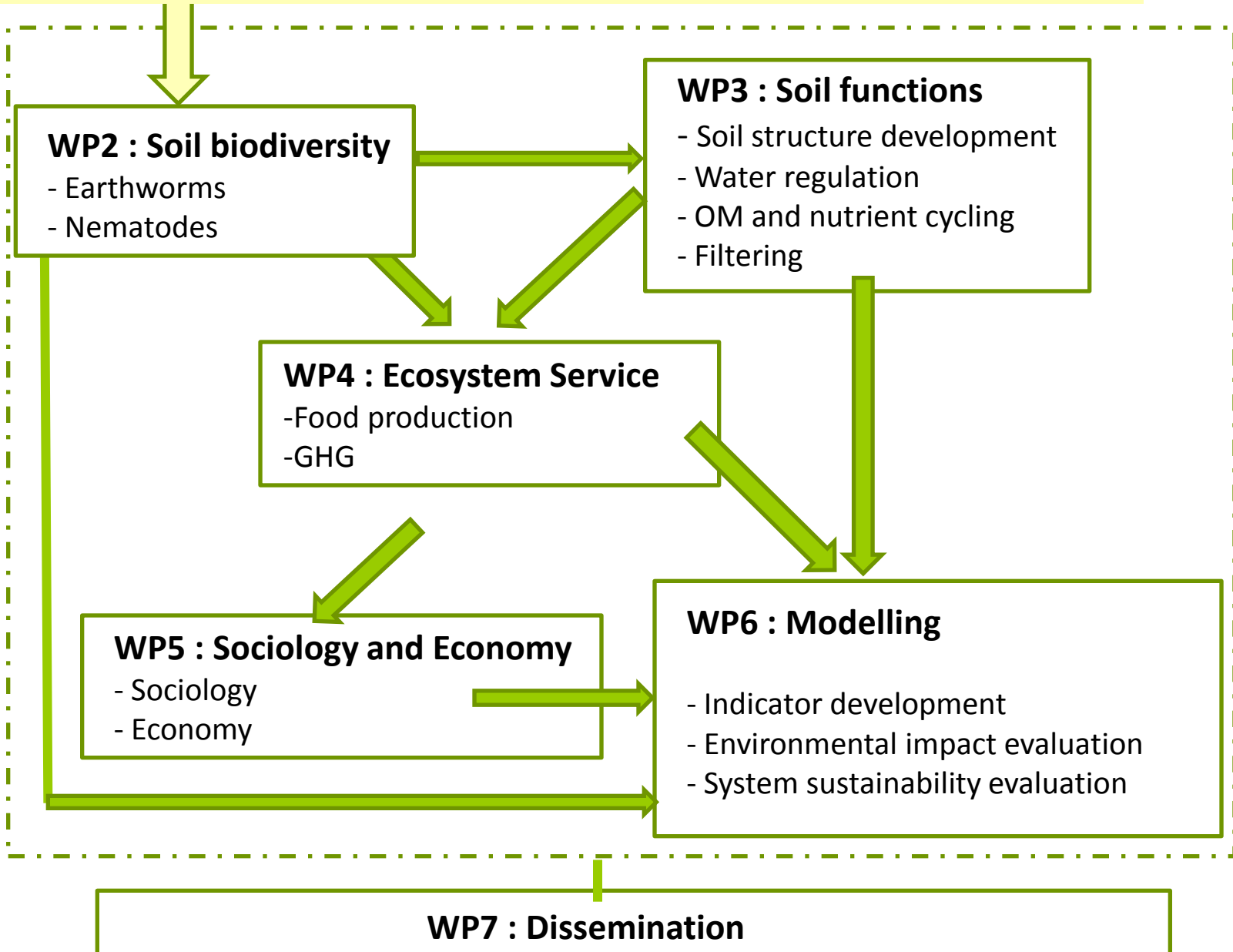
## SNOWMAN NETWORK

Knowledge for sustainable soils



# SUSTAIN Workpackages (7 WPs)

Agricultural practices (tillage, reduced tillage, no tillage)



WP1 : Coordination