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# Soil biodiversity monitoring in France

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A. Leveque and N. Bougon, OFB

on the behalf of GIS Sol



# GIS Sol a Scientific Interest Group on soils dedicated to collect, use and give access to soil data in France

- **Involvement:**

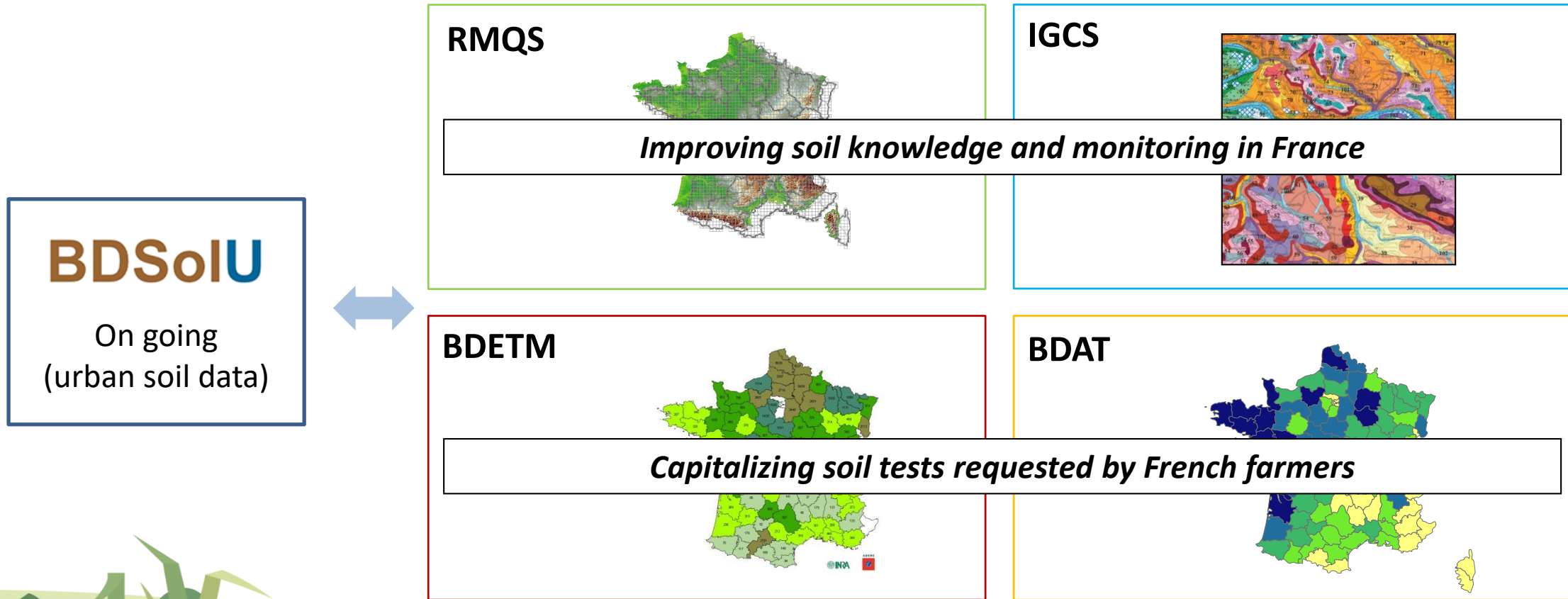
- 2 ministries (Agriculture and Environment),
- 2 national agencies (Environment and Biodiversity)
- 4 research institutes (INRAE, IRD, IGN and BRGM)
- INRAE InfoSol: coordination of programs and databases

- **Main aims:**

- Survey and monitor French soils
- Organize and store soil samples and soil information
- Give access to soil information and samples
- Support public policies

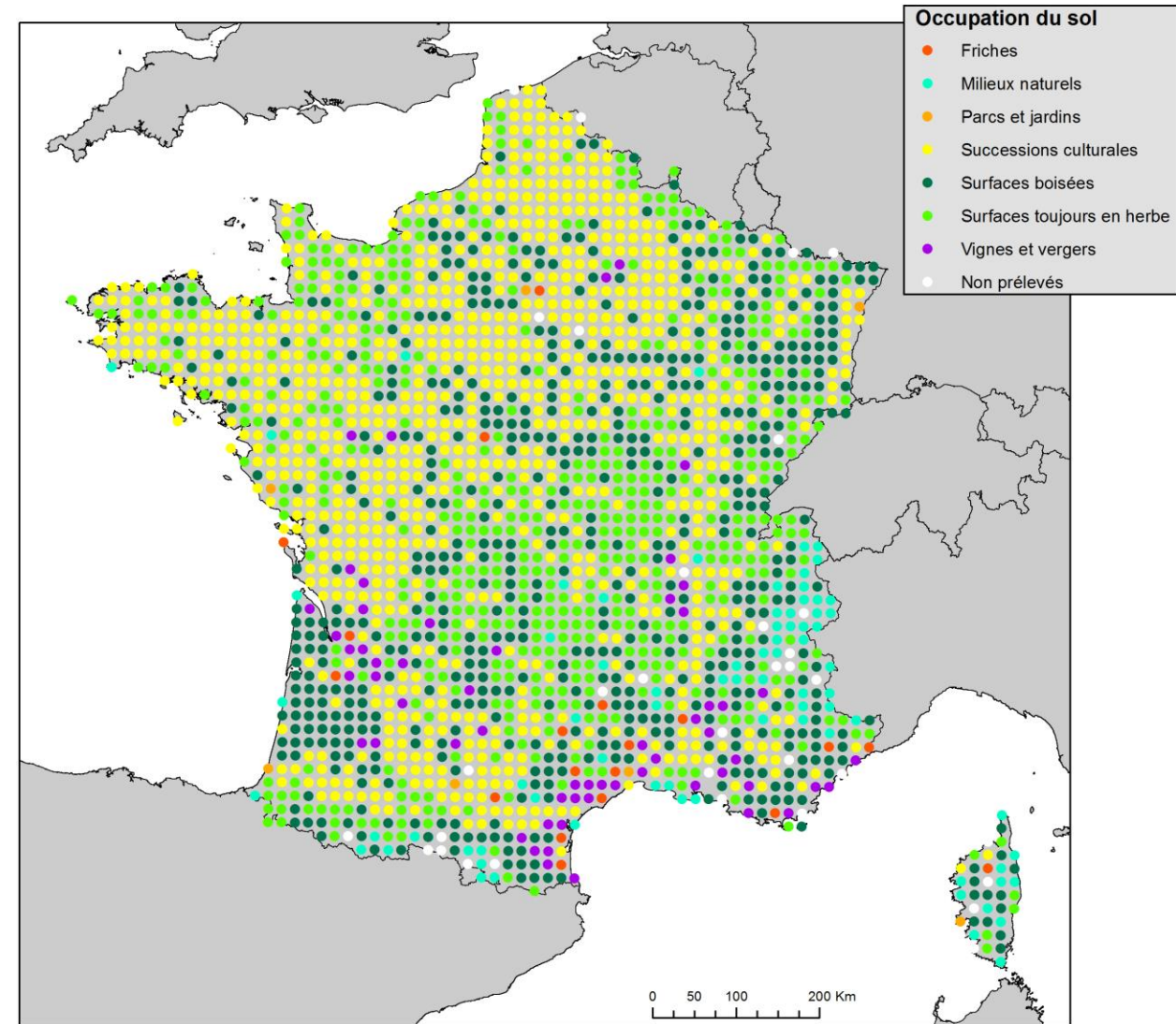


# Four main soil survey and monitoring programmes



# RMQS: French National Soil Quality Network

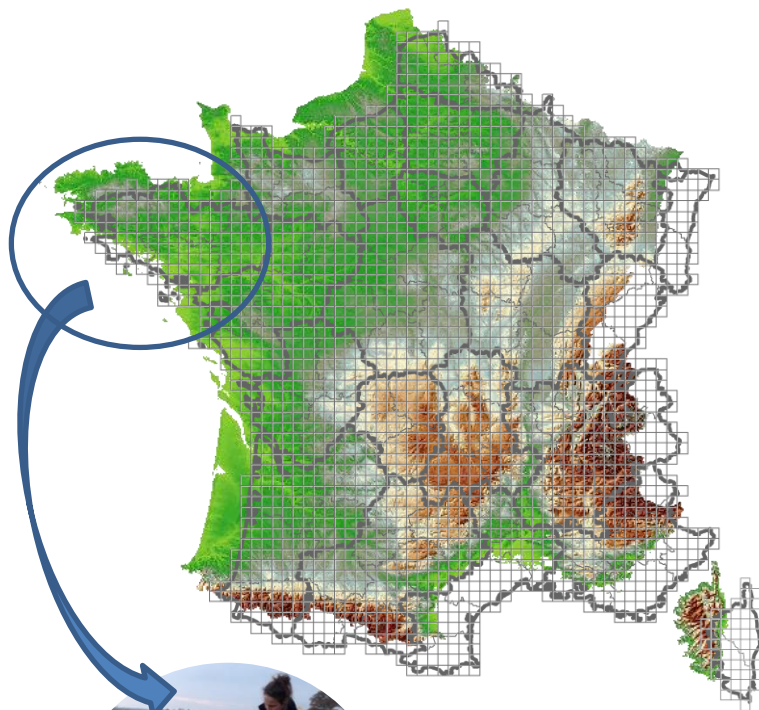
- 2240 sites, 16 km x16 km grid
- On different land uses in continental France and overseas territories
- Each site is sampled every 15 years, since 2000 (2nd campaign started in 2016)
- 12 sub-contracted teams in France doing the fieldwork, based on a common manual
- Data available on soil:
  - Physical and chemical characteristics,
  - Contaminants,
  - Biodiversity,
  - Management practices



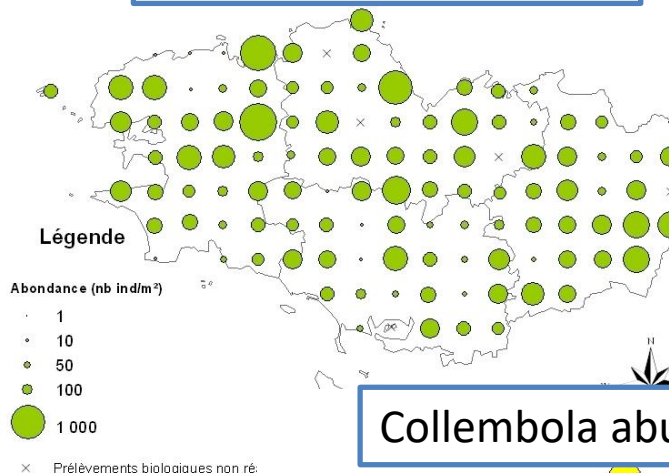
# Early experiences – Soil fauna (2005-2010)

Cluzeau et al. 2012. Integration of biodiversity in soil quality monitoring: Baselines for microbial and soil fauna parameters for different land-use types. *European Journal of Soil Biology*, 2012, vol. 49, p. 63-72.

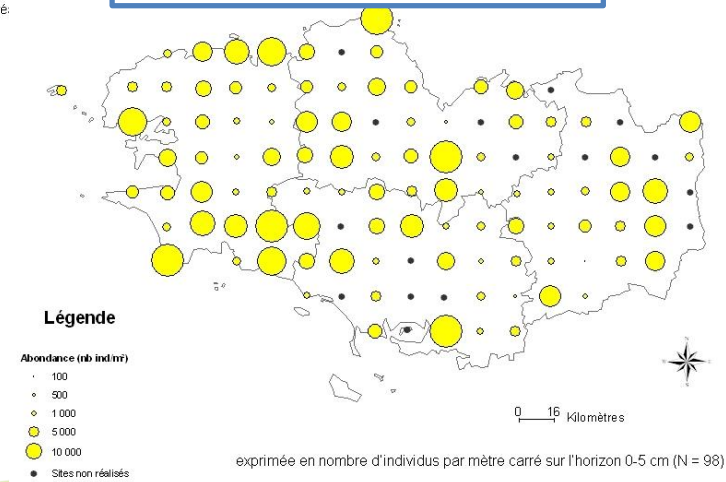
Ponge et al. (2013). The impact of agricultural practices on soil biota: a regional study. *Soil Biology and Biochemistry*, 67, 271-284.



## Earthworms abundance

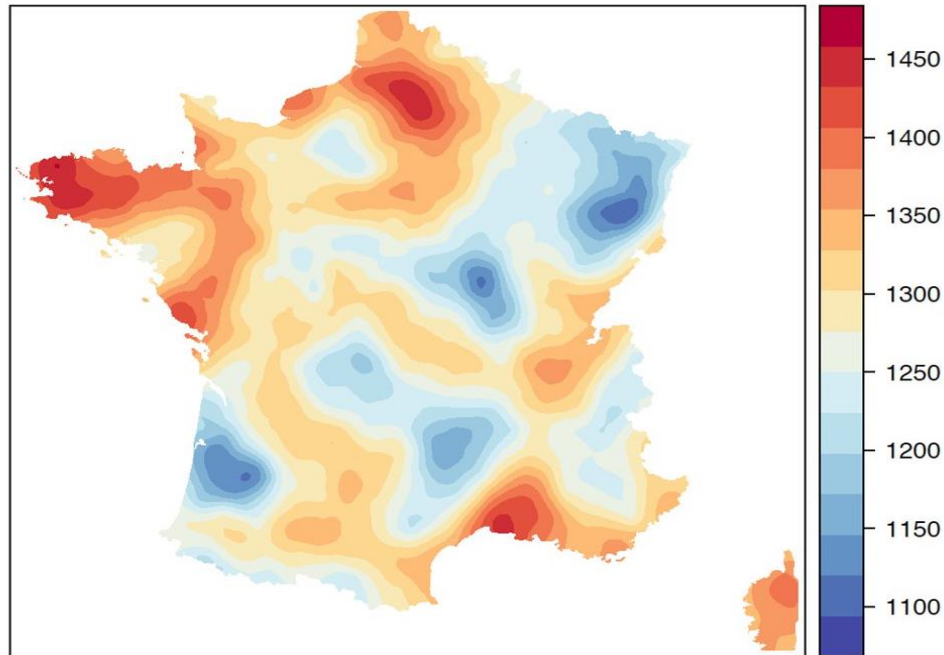


## Collembola abundance



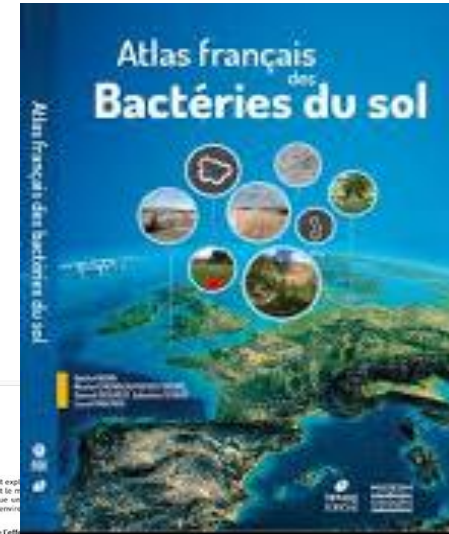
# Early experiences – Microbial biomass and bacterial communities (based on DNA extracts) (2005-...)

Bacterial diversity of soils – France



Source : © GIS Sol, UMR Agroécologie – équipe BIOCUM, plateforme GenoSol

Karimi et al., Environmental Chemistry Letters, 15 (2017)  
 Karimi et al. Science advances, 4(7), eaat1808. 2018



### 19. FIBROBACTERES

**Généralités et distribution géographique**

**Classification:** Milieux de vie: tractsus digestif des mammifères, sols, eaux souterraines, Biofilms, eaux douces, sédiments marins.

**Morphologie et organisation:** Formes de bâtonnets ou cellule ovoide polymorphe.

Classes	Ubiquité (%)	Abondance relative (%)	Métabolisme	Caractères letteurs communs
Fibrobacteria (Fibrobacter sp.)	75	+ 1	Anaérobies obligatoires, hétérotrophes et chemo-organotrophes.	Mésophiles, parfois thermophilus Dégradation de matériaux ligno-celluloseux (composés du glucose, xylan et de la cellulose en acide succinique et en acide succinyl) Développement en présence d'acides gras, de CO <sub>2</sub> , ou de carbonates et de sélénium. Source d'acides aminés aromatisés et aminés.

**Autécologie**

La distribution spatiale des Fibrobactéries est principalement expliquée par des paramètres géographiques et le mode de vie (respectivement 2,2% et 2,1%) et le climat explique en partie la distribution des Fibrobactéries (12,1%).

**Effet des paramètres physico-chimiques du sol**

Paramètre	Abondance relative (%)
pH	1,1 %
Température	3,9 %
Teneur en argiles	1,2 %
Teneur en nitrate	1,5 %

Les Fibrobactéries sont stimulées dans les sols humides, riches en grandes cations, à pH alcalin et riches en phosphore.

**Bactériologie**

Nombre de liens: 23 - NIVEAU ÉLEVÉ

Interactions	Nombre	Phylum concerné
COOPERATION	18	Gemmatimonadetes, Betaproteobacteria, Nitrospirae, Alphaproteobacteria, Acidobacteria, Planctomycetes
ANTAGONISME	5	

Les Fibrobactéries co-occurrent avec les Gemmatimonadetes, les Betaproteobacteria et les Nitrospirae, ce qui s'explique en partie par leur affinité pour des sols humides. Leur coopération avec les Alphaproteobacteria, les Acidobacteria et les Planctomycetes peut s'expliquer par l'abondance plus forte de ces derniers dans des sols acides.

**Distribution spatiale:** Hétérogène et structurée.

**Taille des profils biogéographiques:** Petite taille, 45 km de rayon.

**Régions présentant une abondance élevée:** Nord: Nord – Pas-de-Calais, Basse-Normandie; Ouest: Bretagne.

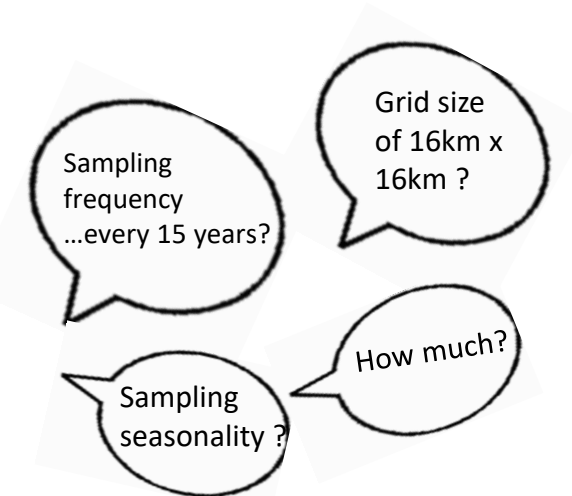
**Régions présentant une abondance faible:** Centre: Limousin, Centre, Bourgogne; Sud-Ouest: Gironde, Landes; Nord-Est: Alsace, Lorraine.

# Currently testing the inclusion of soil biodiversity in the RMQS

- **OFB is in charge of a French long-term biodiversity monitoring network?**
  - Based on these early experiences, in 2018, OFB approached the GIS Sol about the possible inclusion of soil biodiversity in this national network
  - RMQS being the possible device for such measurements (*as already implemented in mainland France and overseas territories*)



- **Our strategy**
  - Ask experts (on the indicators, the sampling strategy, the sampling procedures, the logistical constraints, the costs...)
  - Develop a handbook to be tested, identify relevant labs and estimate costs
  - Test the handbook on field with all partners across France
  - Analyze the results and feedbacks from field operators and labs
  - Conclude...





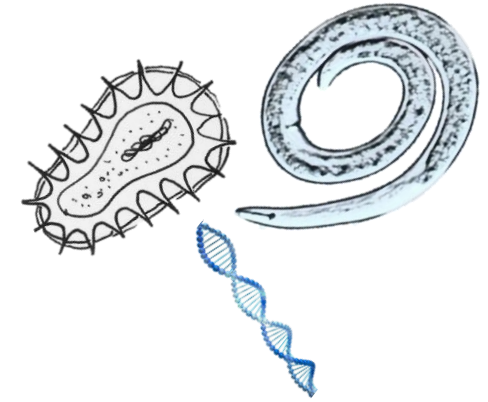
# 5 protocols selected to monitor both taxa and functions

\* Already done in the RMQS

1

Surface soil composite sample\*

Bacteria, Fungi and Protists  
Nematods  
Soil seed bank  
Enzymatic activity  
Organic matter degradation



2

Cylindrical split corer  $\varnothing$  5 cm

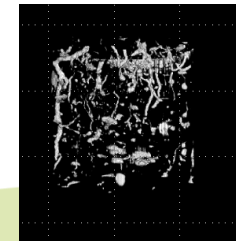
Below-ground mesofauna



3

Cylindrical split corer  $\varnothing$  16 cm

Soil porosity

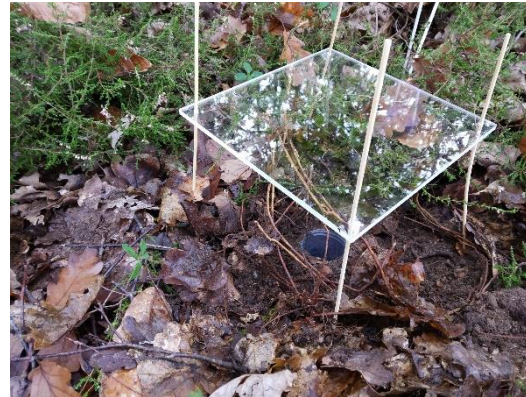


# 5 protocols selected to monitor both taxa and functions

4

6 Pitfall traps

Surface macro and mesofauna



5

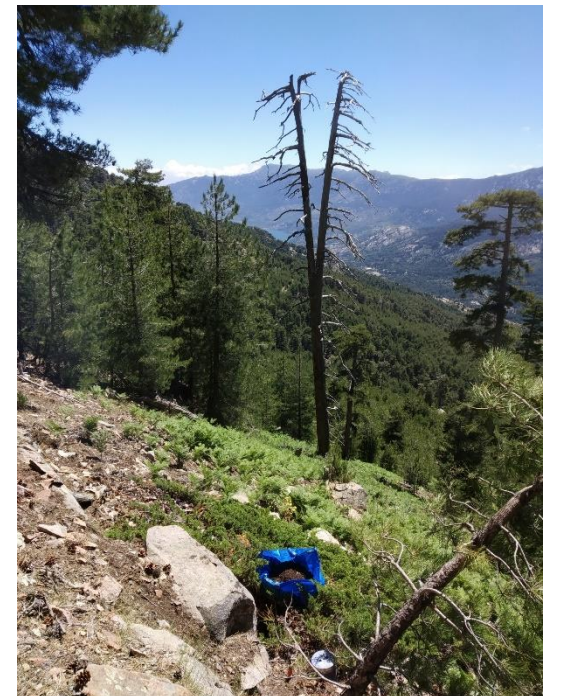
6 Hand sorting of a soil block + mustard

Earthworms and larvae



# First lessons from the field

Until now : around 20 sites sampled  
(10 to come...)



Mean duration for applying on field the 5 protocols: 8h (min ~6h and max ~11h )  
with 2 (or 3) people in addition to the team already involved for classical monitoring



# Next steps and conclusion

- **Next steps :**

- Finish the field testing (February 2022)
- Update the manual, manage and analyze the data (spring 2022)
- Conclude and decide with OFB about what to monitor and how

- **1st conclusions**

- Sampling soil biodiversity is feasible on an existing network (as demonstrated by early experiments)
- Requires time (and money)
- Will we need to adapt the overall monitoring process?

