Key drivers of earthworm community distribution at watershed scale

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1. Background and objectives

❖Soil biodiversity is recognized as playing a crucial role on the provisioning of soil ecosystem services

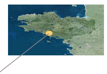
❖Soil biodiversity dynamic and spatial distribution are strongly influenced by anthropic parameters (land use, agricultural practices) and by environmental factors (pedological, climate contexts)

❖Many researches have studied the drivers of earthworm community at fine scale (field) and by modelling have identified divers at large scale (European, Global), but there is still a lack about the drivers at medium scale such as catchment scale reflecting the heterogeneity of agricultural landscape, and models still need to be developed.

➔ **SoilServ** project (ANR project 16-CE32-0005-01) carried in Brittany (France), collected biological, environmental and agronomical data at catchment scale (12 km²) in order to identify which are the main drivers (soil characteristics, land use management, agricultural practices) that affect earthworm distribution. Different models were applied to test the relevance of the different identified drivers.

2a. Catchment description and field campaigns

❖ Study was carried at Kervidy-Naizin catchment (48°00'44"N, 2°49'56"W) characterized by mixed crop-livestock farming systems; catchment is part of ORE *AgrHys*, supervised since 1993 by research institute INRAe.



Location of the 92 sampling sites

❖In march 2018, **92 sites** (29 crops, 25 inter-crops, 34 meadows, 4 woods) were sampled following systematic grid + added sites. At each site : earthworm community, environmental and anthropic paratemers were collected

❖In may 2018, at **29 sites** (winter wheat crop) earthworms + water infiltration measurements were done

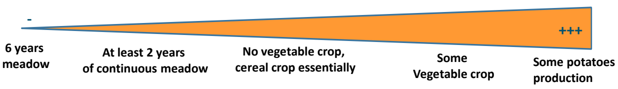
2B. Anthropic data collection

For each site

❖**Land use** in 2018 (crop, inter-crop, permanent or temporary meadow, wood)

❖**History** of the site since 2012 (during 6 years)

➢ Rotation defining a gradient of land use intensification based on the number of years of meadow in the rotation, the presence or absence of vegetable production, the presence of potatoes crop production



➢ Ploughing actions:
- Number of plough
- - depth of plough

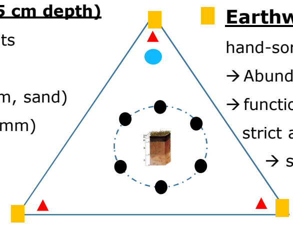
➢ Meadow effect: number of years of meadow preceding the sampling

2C. Biological, chemical and physical parameters collection

Soil samples (0-25 cm depth)
Composite from 6 points
→ C, N, P, pH
→ Texture (% clay, loam, sand) coarse element (>2mm)

Infiltration rate

Earthworm community
hand-sorting (25*25*25 cm) + AITC
→ Abundance (nb/m²), Biomasse (g/m²)
→ functional structure: epigeic, endogeic strict anecic, epi-anecic
→ specific structure



Bulk density (g/cm³)
0-15; 15-25; 25-30 cm depth

Soil description (120 cm depth)
- Hydromorphic state, soil depth, soil type, horizon dimension, soil parental material

2D. Data treatment

1) Different models were compared to select the key drivers
   - RandomForest (RF), Gradient Boosting Trees (GRT), Cubist (Cu)

2) effect of anthropic and environmental parameters on earthworm was tested by Generalised linear mixed models (GLMM)

3) relation between infiltration rate and earthworm community was tested by Generalised Linear Models (GLM)

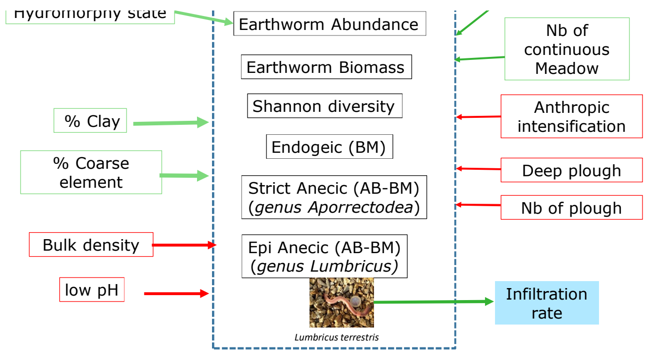
3. Drivers of earthworm community and water regulation

❑ **At catchment scale, earthworm** (abundance, biomass, functional and species diversity) **are mostly driven by:**

❖ **anthropic factors**
- Positive effect of meadow: earthworm communities are affected by the land use at sampling time (permanent meadow = temporary meadow >intercrop> crop) but also by the number of continuous meadow phases before the sampling time
- Negative effect of
  - intensification of crop rotation
  - deep and frequent plough

❖ **environmental factors**
- Positive effect of
  - fine (clay) and coarse (>2mm) texture → suitable soil water retention and nutrient availability
  - hydomorphic state → positive effect of semi-hydromorphic soil on earthworm abundance
- Negative effect of
  - low pH (pH 4) → significant increase from pH4 to pH5-pH7
  - high bulk density

❑ Infiltration is positively correlated with earthworm abundance especially epi-anecic abundance (+0.01 mm.s^{-1} / individu), *L. terrestris* species



4. Conclusions and outlook

SoilServ project: i) reinforces the role played by pH and texture in earthworm spatial distribution, previously noticed at European scale (Rutgers et al., 2016), ii) hightlights new key drivers: bulk density, hydromorphic state, iii) precises agricultural managements which affect biological distribution (land use, rotation), demonstrating the crucial importance of the field agronomical history. The knowledge of agronomical drivers (e.g. nb of years of meadow in crop rotation) is a real tool which could be addressed to farmers in order to maintain/improve earthworm community and associated ecosystem services at catchment scale.

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