

# Ecological Function and Biodiversity Indicators in European Soils EcoFINDERS

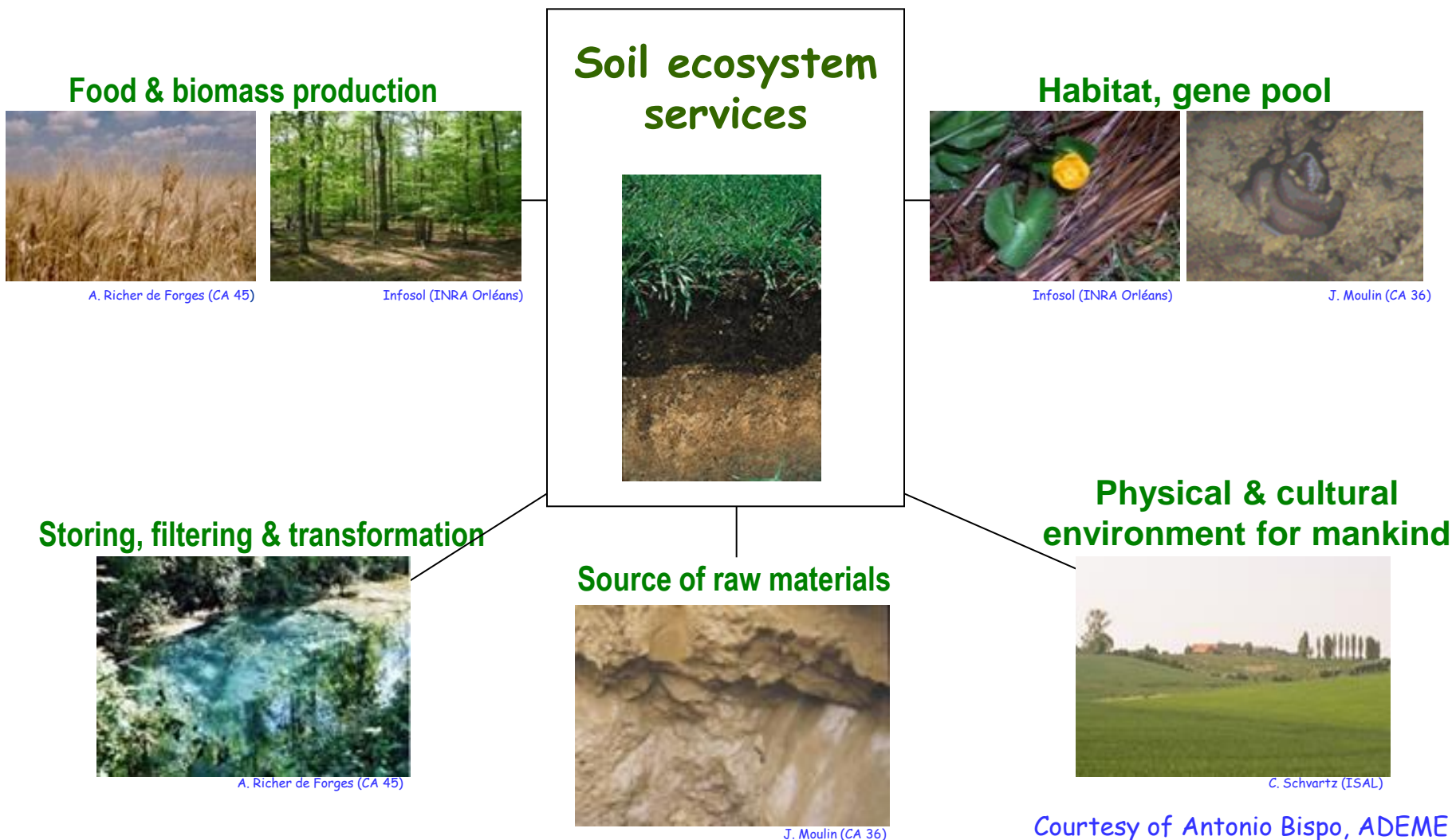


<http://www.ecofinders.eu/>



Meeting of Coordinators, Brussels,  
22-23 October 2012

# Soils deliver many ecosystem services



# Living soils

## ■ Huge quantity of organisms

- Fauna: 1-5 T/ha
- Fungi: 3.5 T/ha
- Bacteria: 1.5 T/ha



F. Ippolito

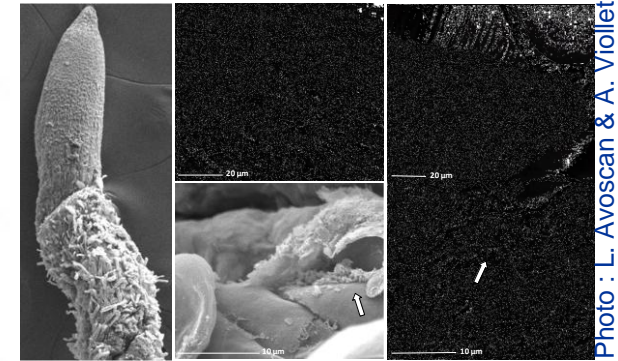
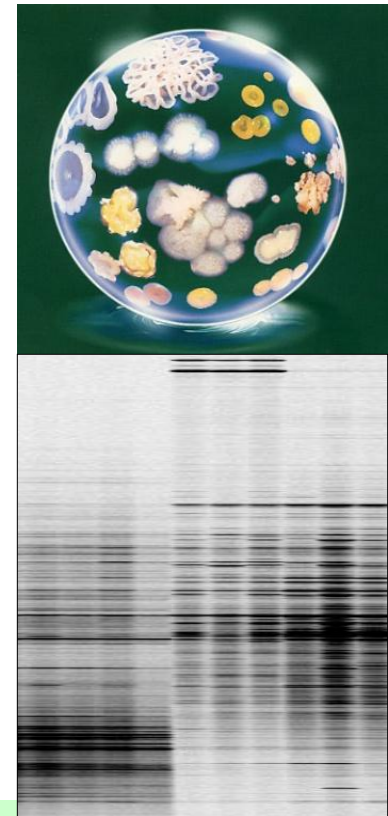


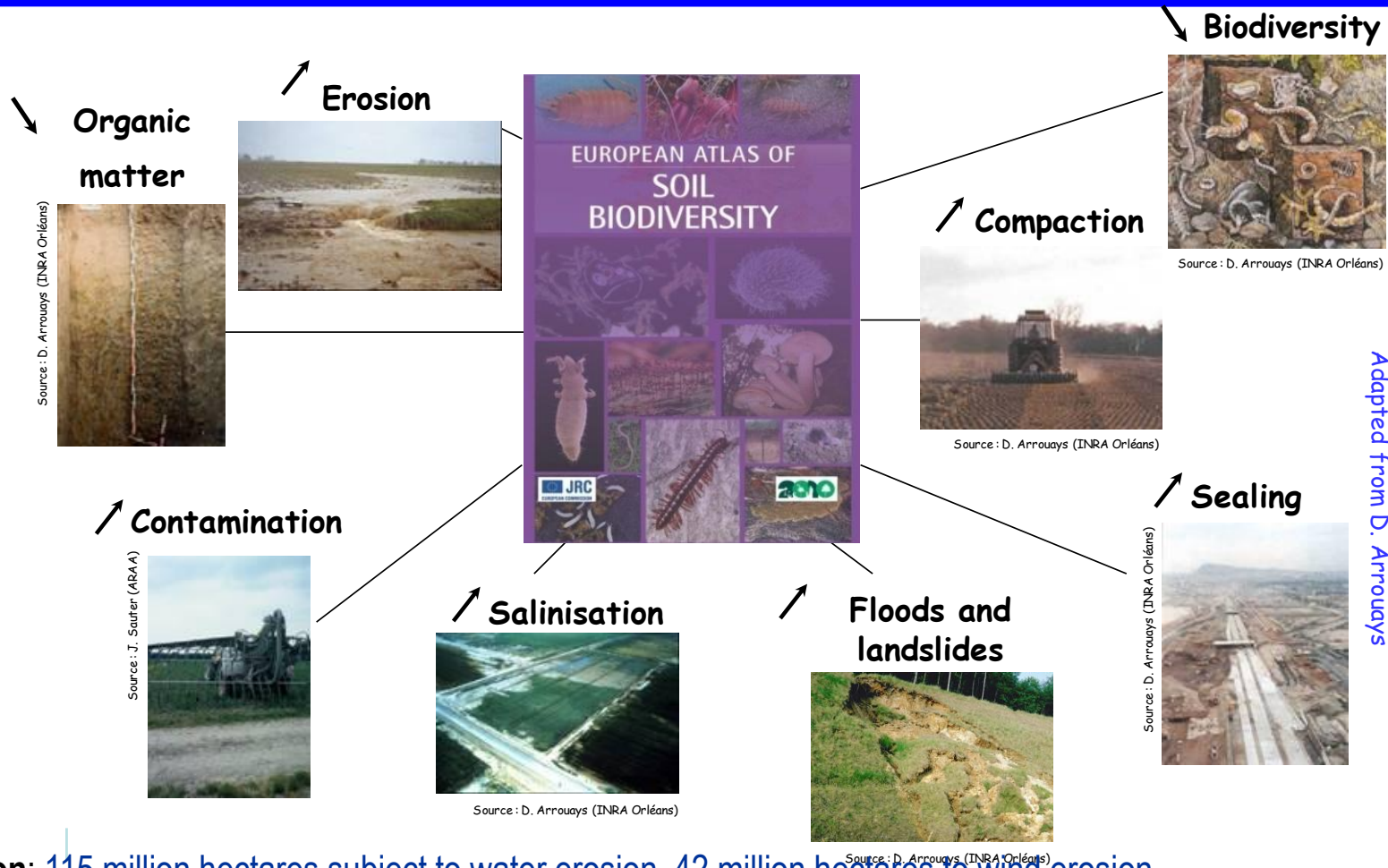
Photo : L. Avoscan & A. Viollet

## ■ Fantastic diversity ...but so little explored...

- Until recently: only access to culturable microorganisms
- Methodological progresses
  - ⇒ possibility to extract DNA from soils
  - ⇒  $10^4 - 10^6$  bacterial genotypes / g sol



# Soils and biodiversity are submitted to major threats



Adapted from D. Arrouays

- **Erosion**: 115 million hectares subject to water erosion, 42 million hectares to wind erosion.
- **Contamination**: 3.5 million sites could be contaminated
- **Decrease of organic matter**: About 45% of European soils have low organic matter content
- **Soil sealing**: 1990-2000: 1,000 km<sup>2</sup> of soil/year , 2000-2006, the average loss increased by 3%

In 2010, EC considered that for establishing Soil Thematic strategy, further knowledge was required on:

- soil biodiversity
- functions and resulting ecosystem services supported by this diversity

This requires:

- the development of standardised methods for the characterisation of soil biodiversity
- the establishment of policy-relevant and cost-effective indicators for biological diversity

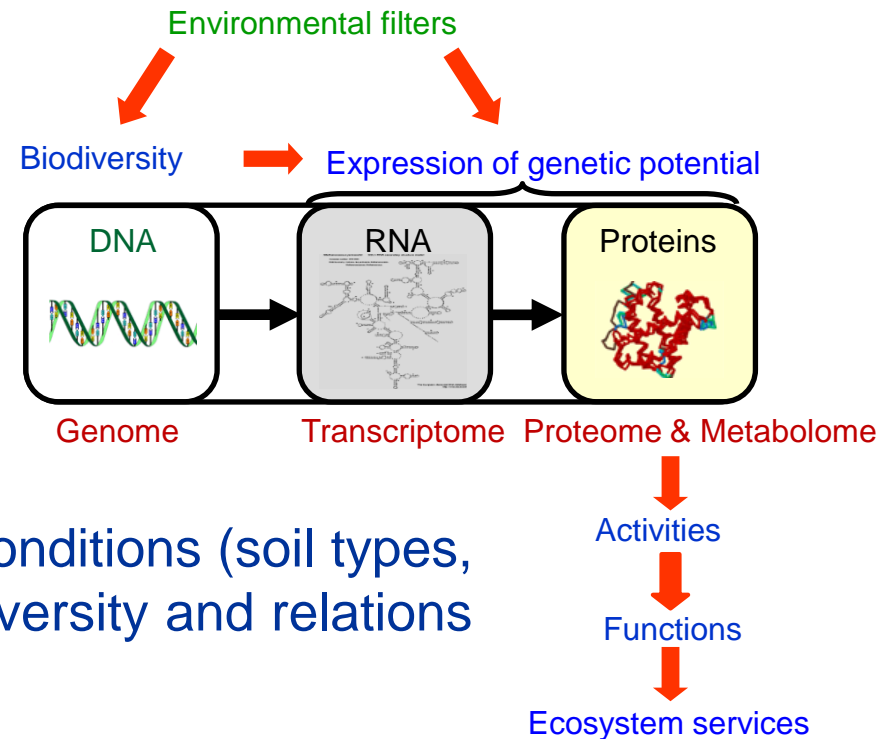
Finally, convincing policy makers of the relevance of such Strategy also requires:

- the assessment of the economic value of the ecosystem services provided.

➡ **ENV.2010.2.1.4.4 Increasing the understanding of the role of soil biodiversity in ecosystem functioning**



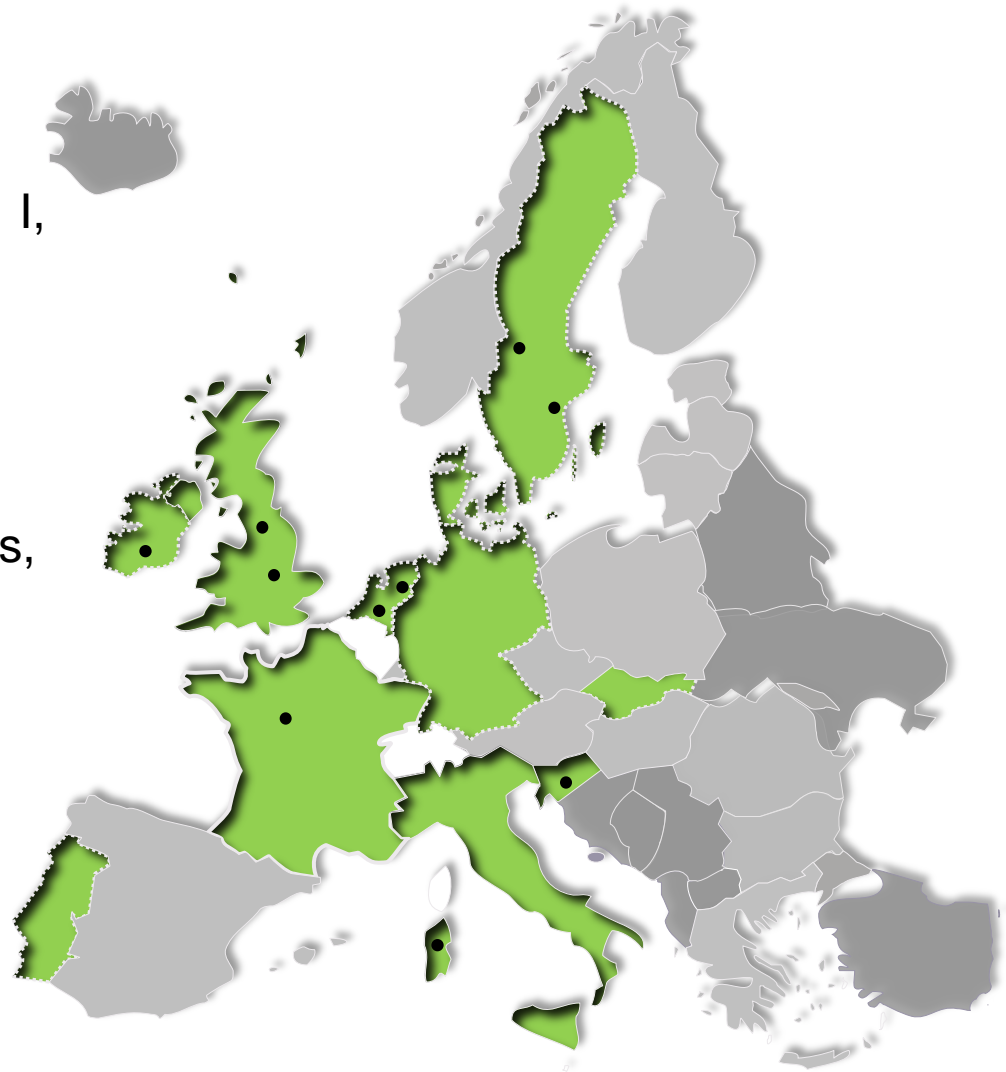
- Decipher relations between soil biodiversity, activities, functions and ecosystem services



- Assess the impact of environmental conditions (soil types, climatic zones, land use) on soil biodiversity and relations biodiversity-activities
- Integrate information on microbial, faunal and plant communities
- Analyse their interactions in food web models and consequences for community and ecosystem stability

# Consortium

- 23 partners
- 10 European countries: D, DK, F, I, IRL, NL, P, S, SK, SLO, UK
- Non-European country: China
- Bringing expertises in various :
  - ✓ **disciplines:** biodiversity, ecological functions, trophic nets, risk assessment, biological indicators, environmental economics
  - ✓ **soil organisms:** archaea, bacteria, fungi, protozoa, microarthropods, oligochatea



## Standardization of sampling procedures



- Where, when and how take samples, number of replicates, sampling depth, use of composite samples, ...

*Plassart et al., in preparation*

INTERNATIONAL  
STANDARD

ISO  
10381-1

First edition  
2002-12-15

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Soil quality — Sampling —

Part 1:  
Guidance on the design of sampling  
programmes

## Optimisation of DNA extraction

- Assessment of possible biases according to the soil type
- Optimisation to allow extraction of DNA of the major types of organisms targeted
  - ✓ Microorganisms (archaea, bacteria, fungi)  
*Plassart et al. 2012. PLoS One*
  - ✓ Fauna (protozoa, nematodes,...)

## Identification of bioindicators

- Sensitive
- Consistent – reliable
- Cost-effective
- [Table Annual Reports.docx](#)

## Standardization of methods for biodiversity characterization



## Characterization of biodiversity across Europe

### Aims at assessing:

- ✓ Range of variations according to soil types, to climatic zones and to land uses
- ✓ Range of variations of the identified bioindicators according to soil types, climatic zones and land uses
- ➡ Definition of the 'Normal Operating Range'

### Strategy:

- ✓ Using data derived from the Joint Research Council, 255 points sampled across Europe to derive indicative values for: Organic Carbon, Texture, pH
- ✓ Overlaid onto the LUCAS – landcover survey and sites identified as either forest, grass or tillage.
- ✓ Identification of 80 sites per land-use type across Europe to give a range of the above soil properties

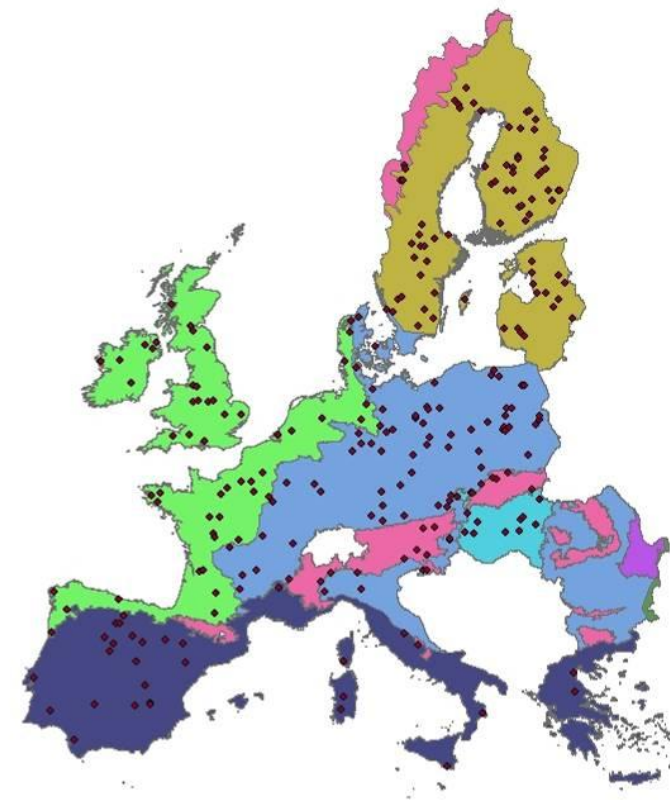
#### Legend

• Random\_Points\_2

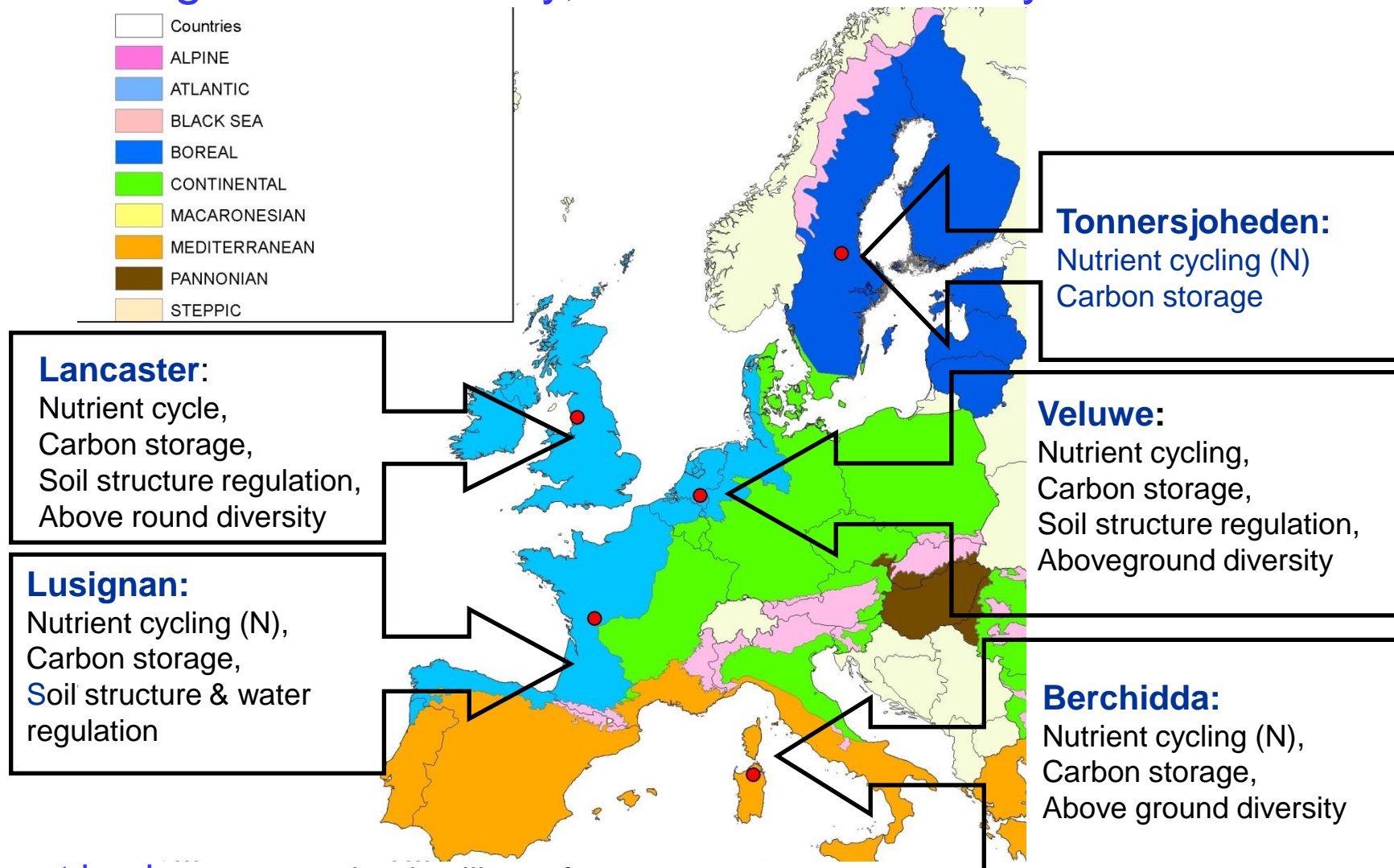
#### Biogeo

#### Region

- ALPINE
- ATLANTIC
- BLK
- BOREAL
- CON
- MACARO
- MED
- PAN
- STEPPIC



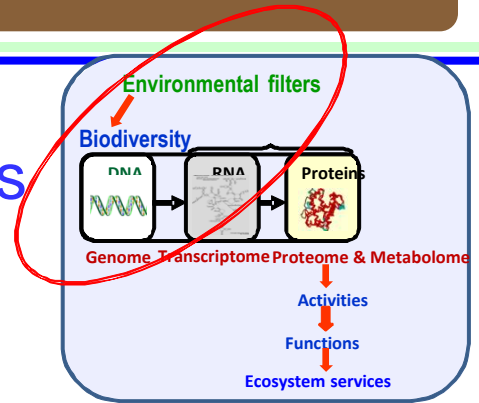
## Connecting soil biodiversity, functions and ecosystem services



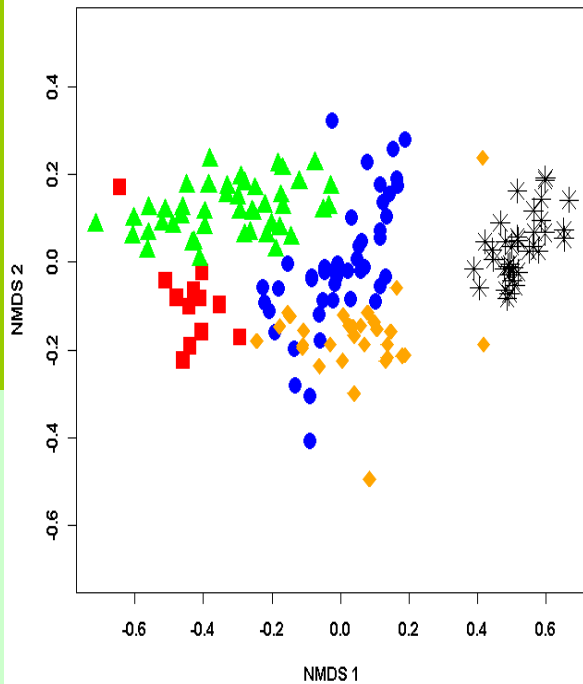
■ Different land uses: grasslands, tillage, forests

■ For each LTO: three levels of intensification

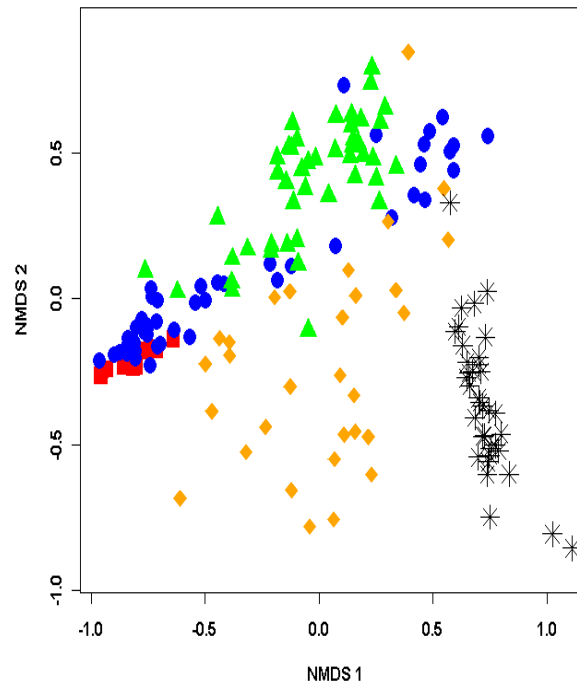
## Microbial diversity varies according to the LTOs



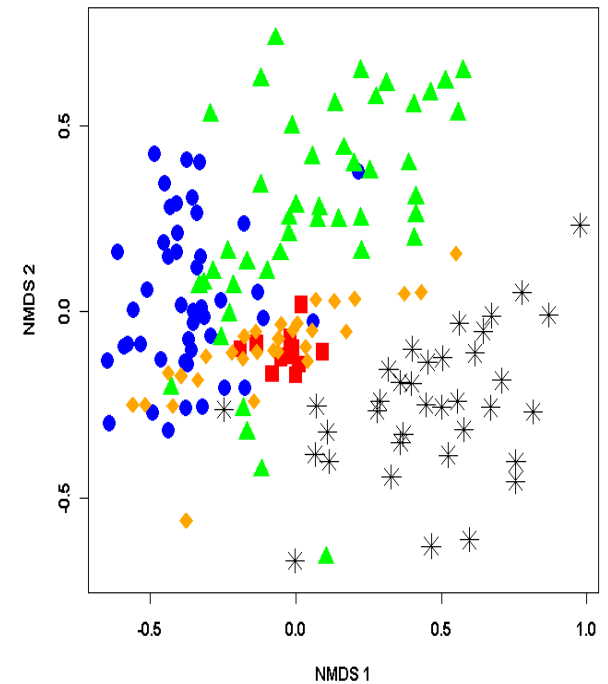
Bacteria



Archaea



Fungi



■ Lusignan

● Berchidda

▲ Lancaster

◆ Veluwe

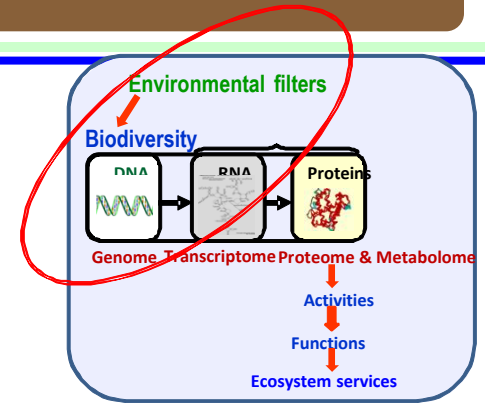
\* Tonnersjoheden



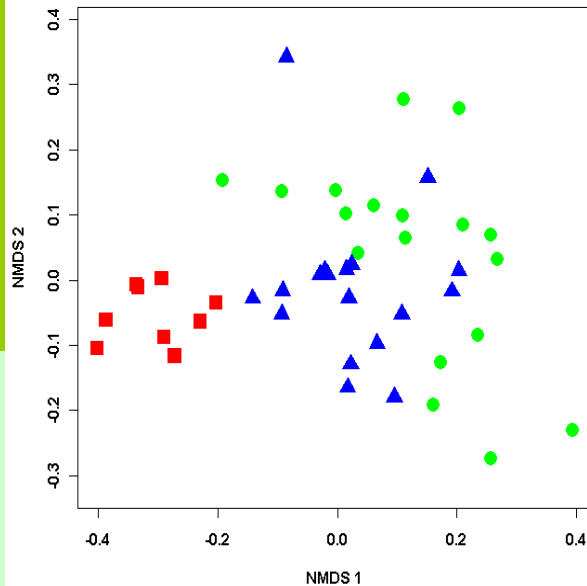
# EcoFINDERS - LTOs

Within a given LTO, microbial diversity differ according to the level of intensification

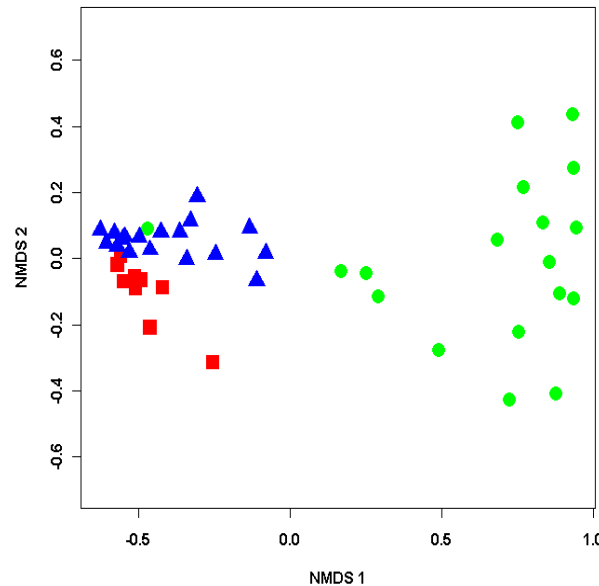
*e.g. Berchidda, Sardinia, Italy*



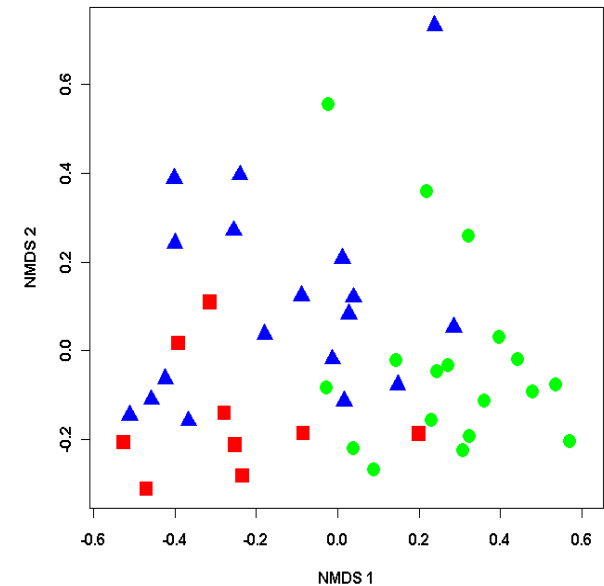
Bacteria



Archaea



Fungi

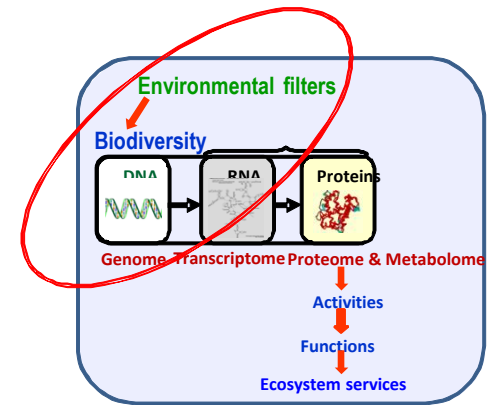
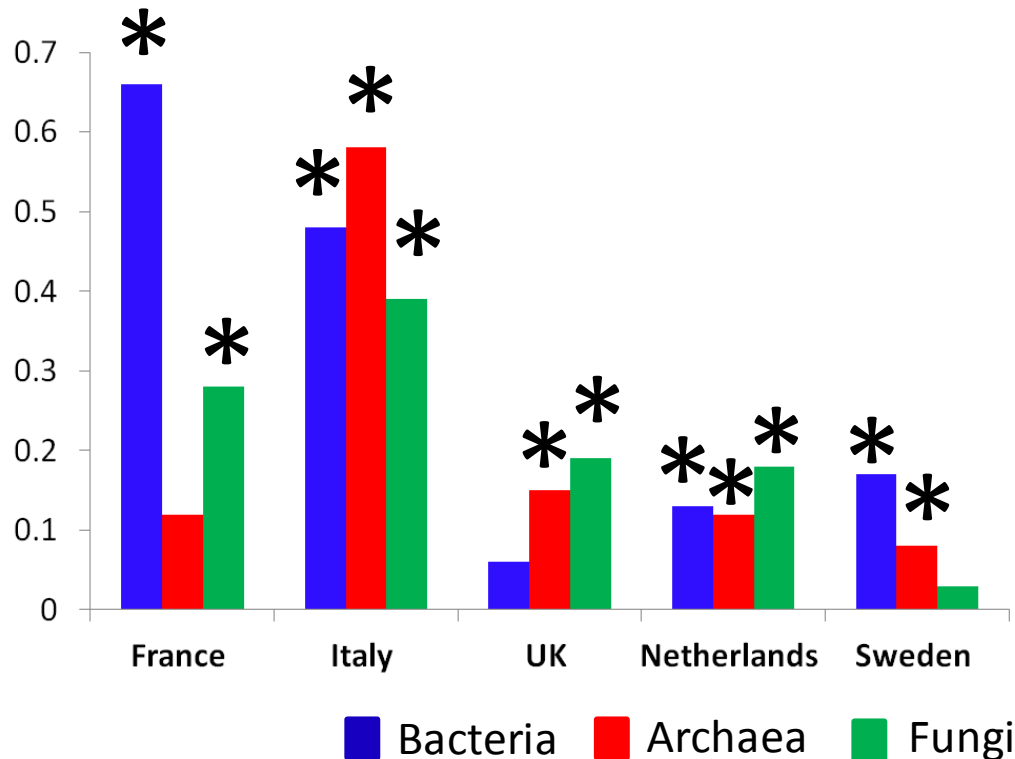


● Wooded land (Low intensity)    ▲ Wooded pasture (Medium intensity)

■ Intensive grassland (High intensity)

Within a given LTO, microbial diversity differ according to the level of intensification

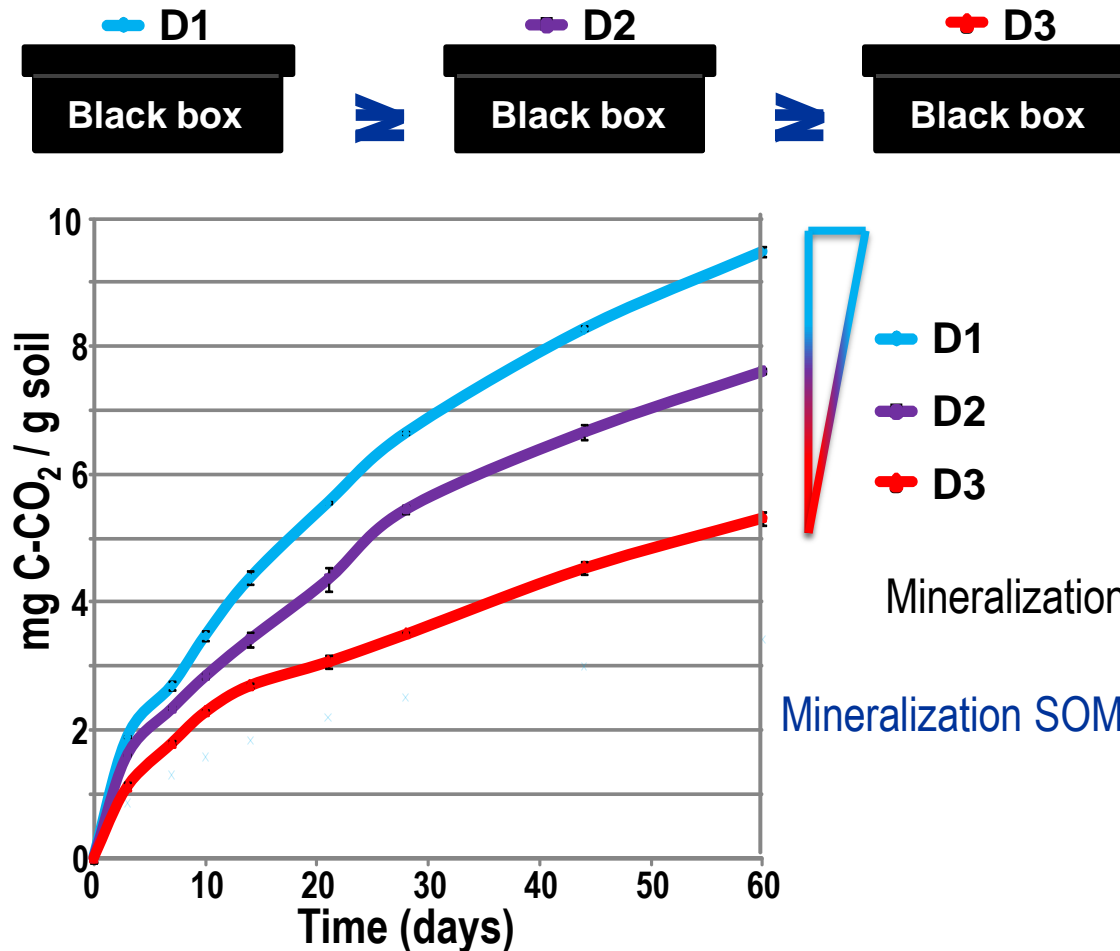
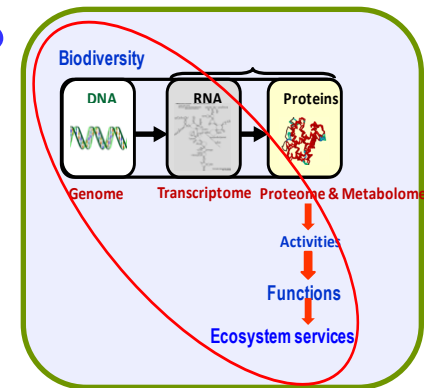
Overall effect of land-use intensity





How these variations translate in soil functioning?

SOM mineralization

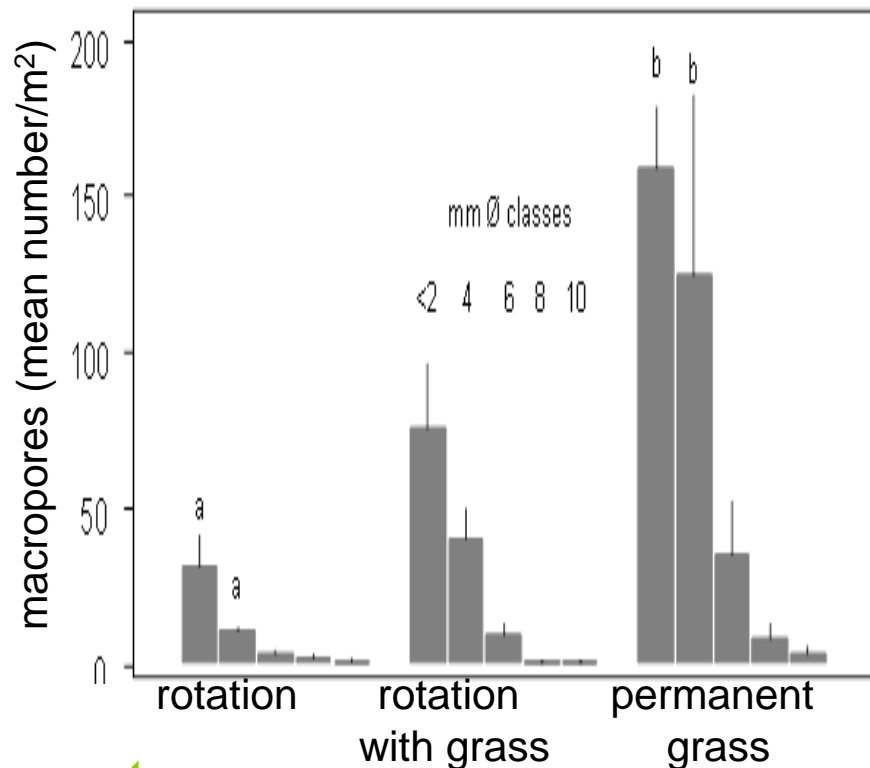


Mineralization D1 > D2 > D3

Mineralization SOM = f (Microbial diversity)

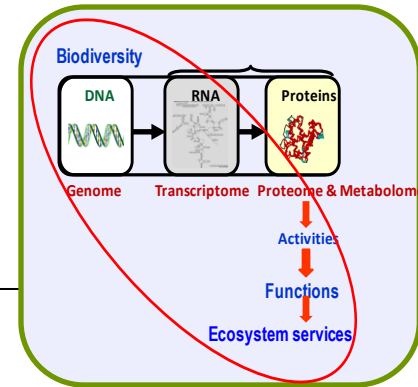
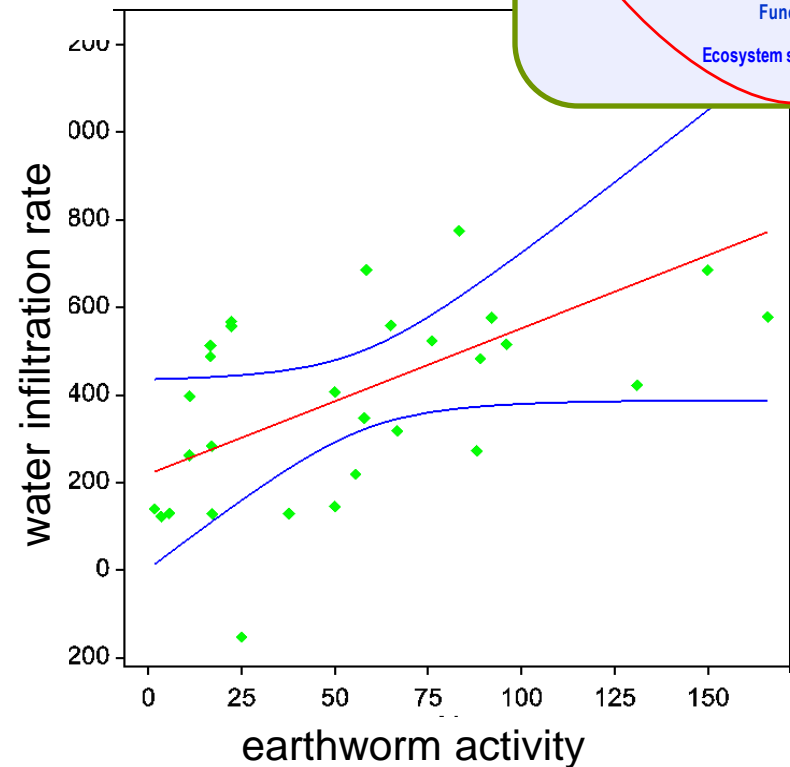
## How these variations translate in soil functioning?

### Water regulation



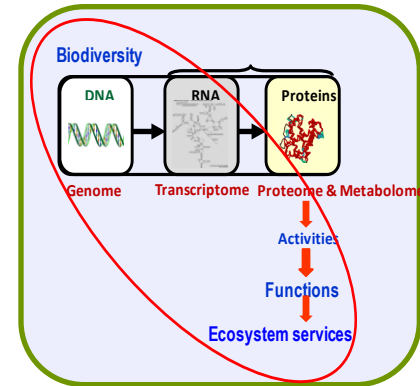
← level of intensification →

+ -



# Mesocosm experiments

## Assessing hypotheses raised from LTOs studies



- ✓ . Minimal diversity for a function to be expressed
- ✓ Relations between above and below ground biodiversity
  - How plant communities affect the resistance and resilience of belowground communities to drought?
  - Impact of plant-derived C into the soil and different soil biota, in connections with soil food web and associated processes.

# Dissemination



OPEN ACCESS Freely available online

PLOS ONE

## Evaluation of the ISO Standard 11063 DNA Extraction Procedure for Assessing Soil Microbial Abundance and Community Structure

Pierre Plassart<sup>1,2,3</sup>, Sébastien Terrat<sup>2,3</sup>, Bruce Thomson<sup>3,4</sup>, Robert Griffiths<sup>3</sup>, Samuel Dequiedt<sup>2</sup>, Mélanie Lelievre<sup>2</sup>, Tiffanie Regnier<sup>2</sup>, Virginie Nowak<sup>1,2</sup>, Mark Bailey<sup>2</sup>, Philippe Lemaire<sup>1</sup>, Chabbi<sup>5</sup>, Pierre-Alain Maron<sup>1,2</sup>, Christophe Mougel<sup>1,2</sup>, Lionel Ranjard<sup>1,2,3,4,5</sup>

<sup>1</sup>INRA, UR1132, 1717 Route de St Genès, 33170 Grignols, France, <sup>2</sup>Plateforme GenoSol, INRA, UMR1347 Agroécologie, Dijon, France, <sup>3</sup>Centre for Ecology & Hydrology, Wallingford, United Kingdom, <sup>4</sup>INRA, UR1132, 1717 Route de St Genès, 33170 Grignols, France, <sup>5</sup>INRA-UEFE, Les Verrières, Lusignan, France

## TUTTI GIÙ PER TERRA

Soil, Biodiversity & Life

PhD Course Symposium  
Soil, Biodiversity and Life

Wageningen  
November 18-21, 2012

## EcoFINDERS

européen

iversity Indicators in European Soils)  
ject (2011-2015)

COFINDERS

caractériser la biodiversité et  
fonctionnement des sols en Europe  
partenaires de 10 pays européens et la chine



mission européenne souhaite mettre en oeuvre une politique de gestion  
sols qui constituent les sols à travers une directive cadre. Une volonté  
sances scientifiques et opérationnelles sur la biodiversité et le

ators in European Soils) project will result in:  
ersity and its role in ecosystem services across different soils,  
d operating procedures for characterizing soil biodiversity and  
ought by cost-effective bioindicators, and of cost effectiveness

services  
ous essential  
such as:  
y (including  
stry products);  
rochemical cycles  
i for the climate);  
istance to diseases  
above-ground



Approaches:  
+ description of soil biodiversity and of  
the relations between soil biodiversity,  
soil functions and ecosystem services,  
in long term observatories  
representative of soil types, climates

Symposium & Post-Graduate course  
**Current Themes in Ecology**

Soil, Biodiversity and Life

The contribution of soils to sustainability of life

The EcoFINDERS project is organizing a PhD course (2012, November 18-21, 2012)

For more information on the PhD course, a coordination

For more information on the EcoFINDERS 2 coordination

In conjunction with this, the Consortium is meeting for the annual

EcoFINDERS in Research Media

**Digging deeper**



di scienze Agrarie e Ambientali  
Vegetale Agraria, Università di Sassari  
Info: info.ecofinders@uniss.it

Lund University (S)  
Netherlands Institute for Ecology (NL)  
Rijkswaterstaat voor Volksgezondheid en Milieu (NL)  
Sveriges lantbruksuniversitet (S)  
Teagasc Agriculture and Food Development Authority (IRL)  
IMAR—Instituto do Mar (P)  
Università di Torino, Università di Sassari (I)  
University College Dublin (IRL)  
University of Aberdeen (UK)  
University of Cambridge (UK)  
University of Lancaster (UK)  
Wageningen University (NL)  
Stichting Dienst Landbouwkundig Onderzoek (NL)  
Inst. for Foresting of the Slovak Academy of Sciences (SK)  
Chinese Agricultural University (CH)



Indicatori di funzioni  
ecologiche e biodiversità  
nei suoli europei  
[www.ecofinders.eu](http://www.ecofinders.eu)



**BERLIN**  
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SETAC Europe 22nd Annual Meeting | 20-24 May

2007 - 2013



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- Plassart P., Terrat S., Thomson. B., Griffiths R. , Dequiedt S., Lelievre M., Regnier T., Nowakv., Bailey M., Lemanceau P., Bispo A., Chabbi A., Maron P.-A., Mougel C., Ranjard L. 2012. Evaluation of the ISO standard 11063 DNA extraction procedure for assessing soil microbial abundance and community structure. PLoS One 7: e44279.
- Ranjard L. et al. Evaluation of the ISO standard 11063 DNA extraction procedure for assessing soil microbial abundance and community structure.



## ■ Conclusions

- ✓ In contrast with the statement made by Beijerinck in 1913, everything is **not** everywhere, biodiversity is not randomly distributed
- ✓ The same organisms are not found everywhere
- ✓ Progresses in the knowledge of the environmental filters impacting soil biodiversity: soil physico-chemical, especially pH, and land use
  - ⇒ Relevance of the 'Normal Operating Range' concept
  - ⇒ Need of data bases for diagnostic of the soil biodiversity
  - ⇒ Need of Standard Operating Procedures

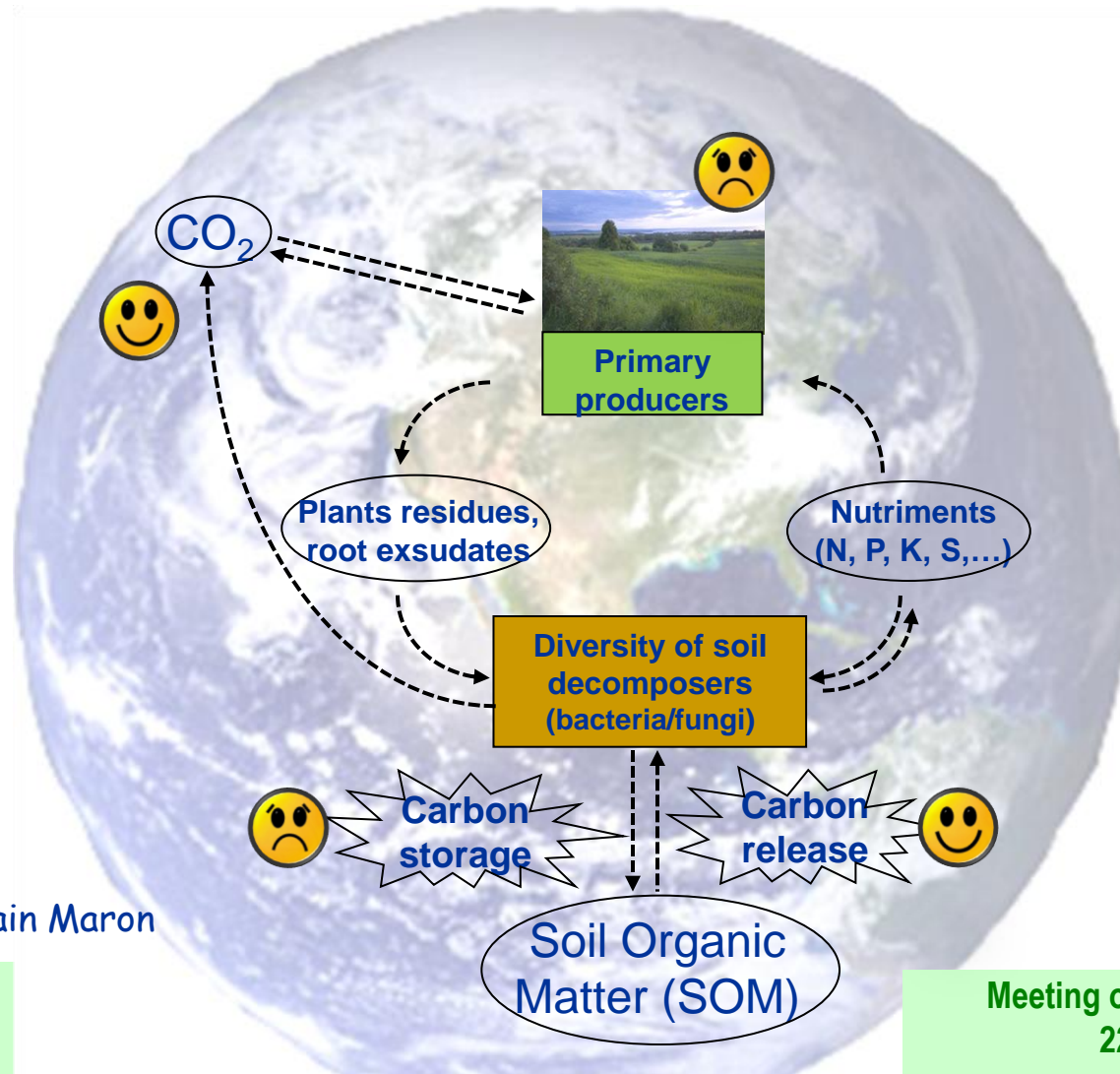
## ■ Challenges: Moving from diagnosis to action

- ✓ Based on diagnosis, define strategies of mitigation and soil restoration
- ✓ This requires
  - ✓ to further progress in our knowledge of the soil functioning as supported by biodiversity
  - ✓ to combine expertises in soil physics, chemistry, ecology

# Conclusions and challenges

## Challenges: Moving from diagnosis to action

- ✓ to deal with possible trade-offs



Courtesy of Pierre-Alain Maron

# Conclusions and challenges

## ■ Challenges: Moving from diagnosis to action

- ✓ to guarantee the soil multifunctionalities at different spatial and temporal scales



- ✓ to capitalise European and National means and information on a set of Critical Zones Observatories and Long Term Observatories
- ✓ to match with world global initiatives

