

EcoFINDERS



Ecological Function and Biodiversity Indicators in European Soils

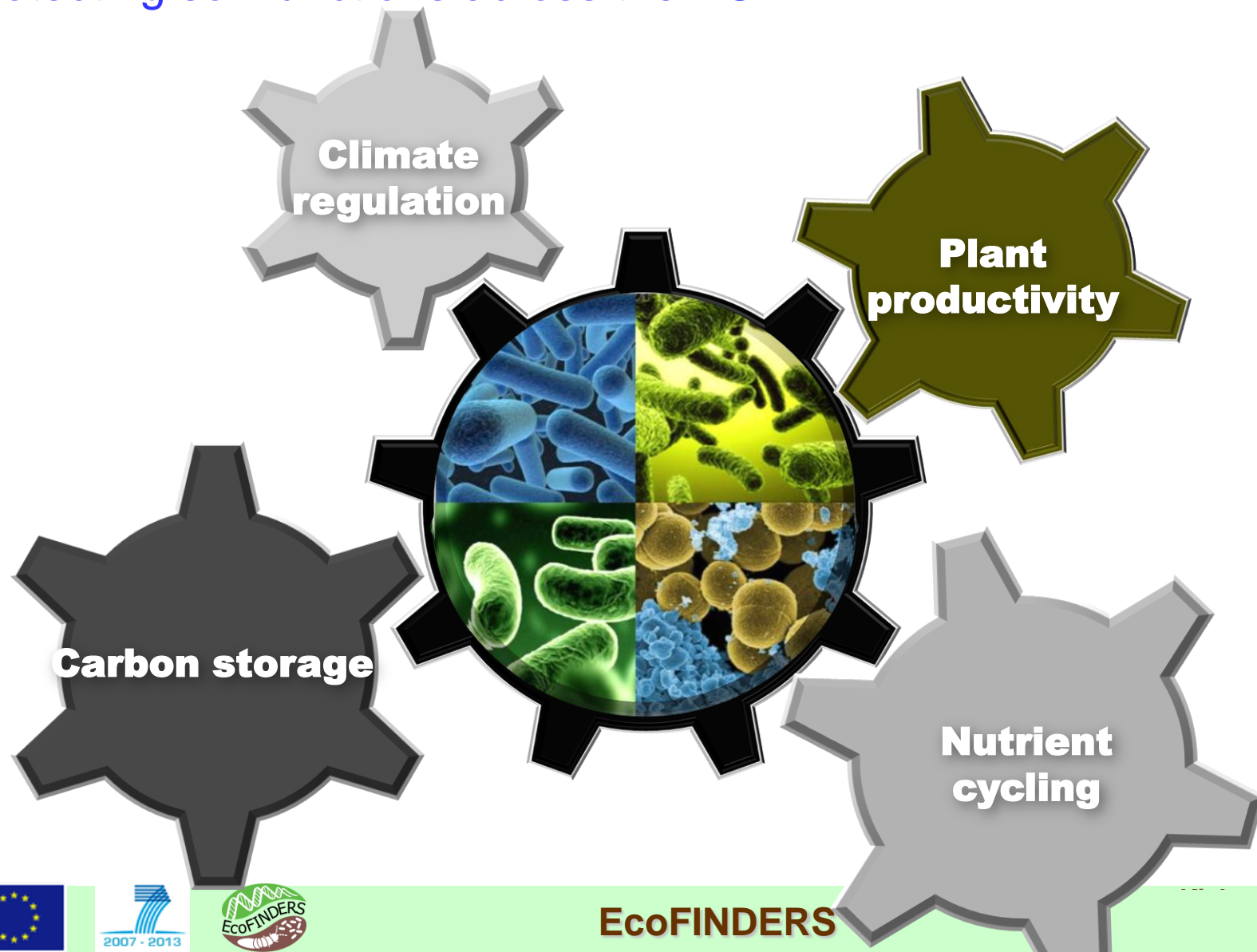
Philippe Lemanceau
INRA, Dijon, France



EcoFINDERS

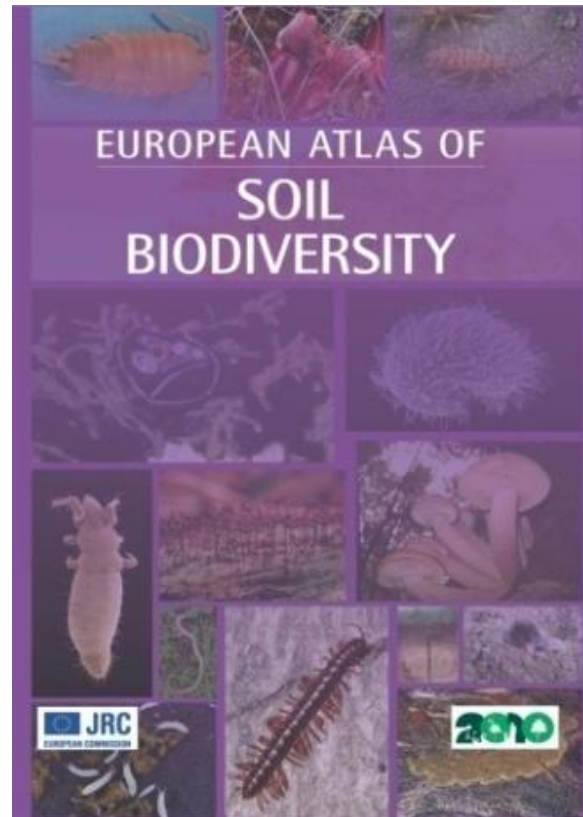
EU Soil Thematic Strategy

Soil Thematic Strategy adopted by the Commission in 2006 aims at protecting soil functions across the EU



EU Soil Thematic Strategy

Soils and biodiversity are submitted to major threats



For establishing such strategy, EC considers that knowledge is missing 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**

Living soils

■ Huge quantity of organisms

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

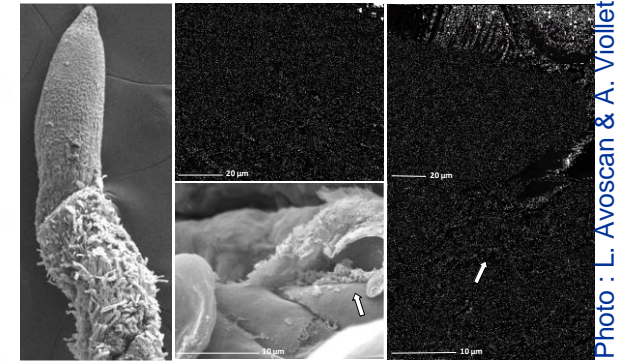
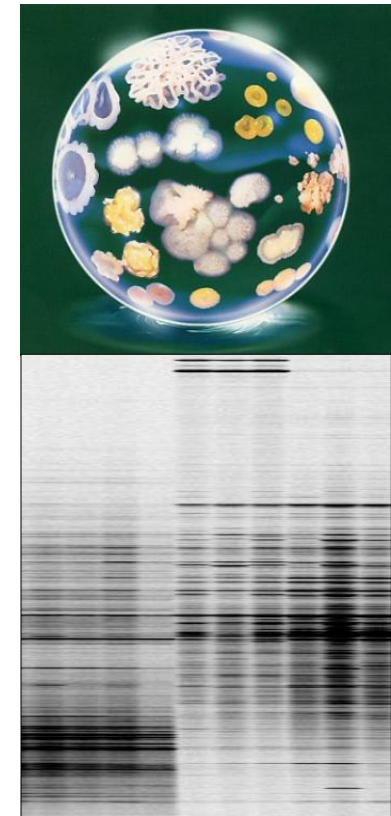


Photo : L. Avoscan & A. Violet

■ 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



Characterizing soil biodiversity: a difficult task

Reasons for that:

- Size of the organisms
- Their 'hidden' localization
- The heterogeneity of the soil matrix
- The huge biodiversity
- The high variety of environmental situations: types of soils, climates, land use
- The lack of standardized operating procedures making difficult comparisons between studies

General objectives

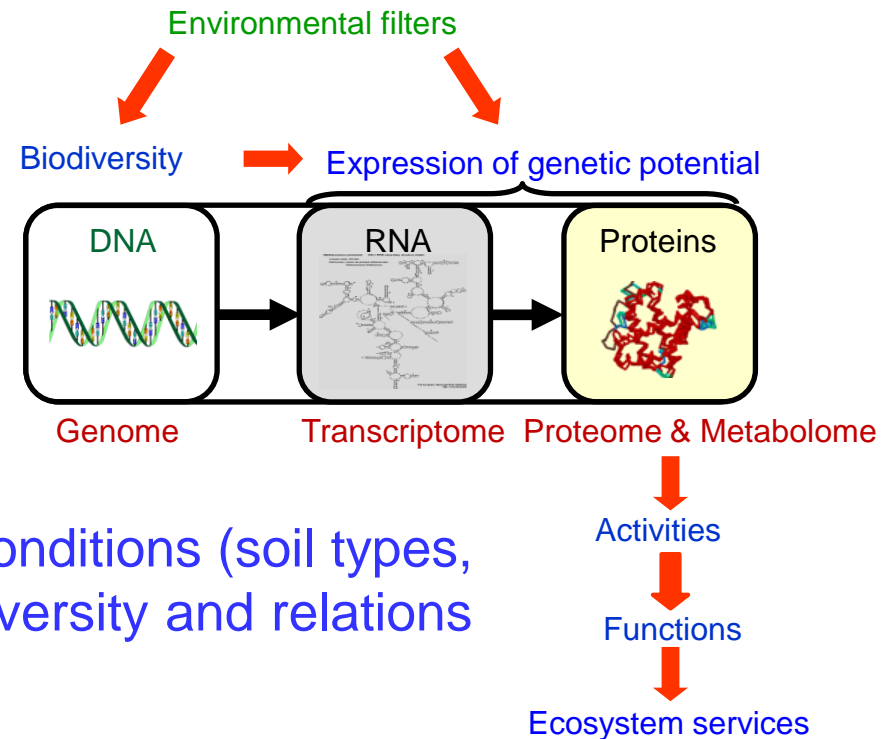
The strategic aim of EcoFINDERS is to provide the European Commission with necessary tools to design and implement soil strategies aimed at ensuring sustainable use of soils; including:

- Characterizing biodiversity (microbes and fauna) of European soils
- Deciphering their interactions through trophic foodwebs
- Determining relations between soil biodiversity, functions and ecosystem services
- Assessing the impact of environmental parameters on soil biodiversity, and relation diversity-functions-ecosystem services
- Designing policy-relevant and cost-effective indicators for monitoring soil biodiversity and activity



Concepts

- 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



Overall strategies

■ Combine three types of approach

✓ Observation

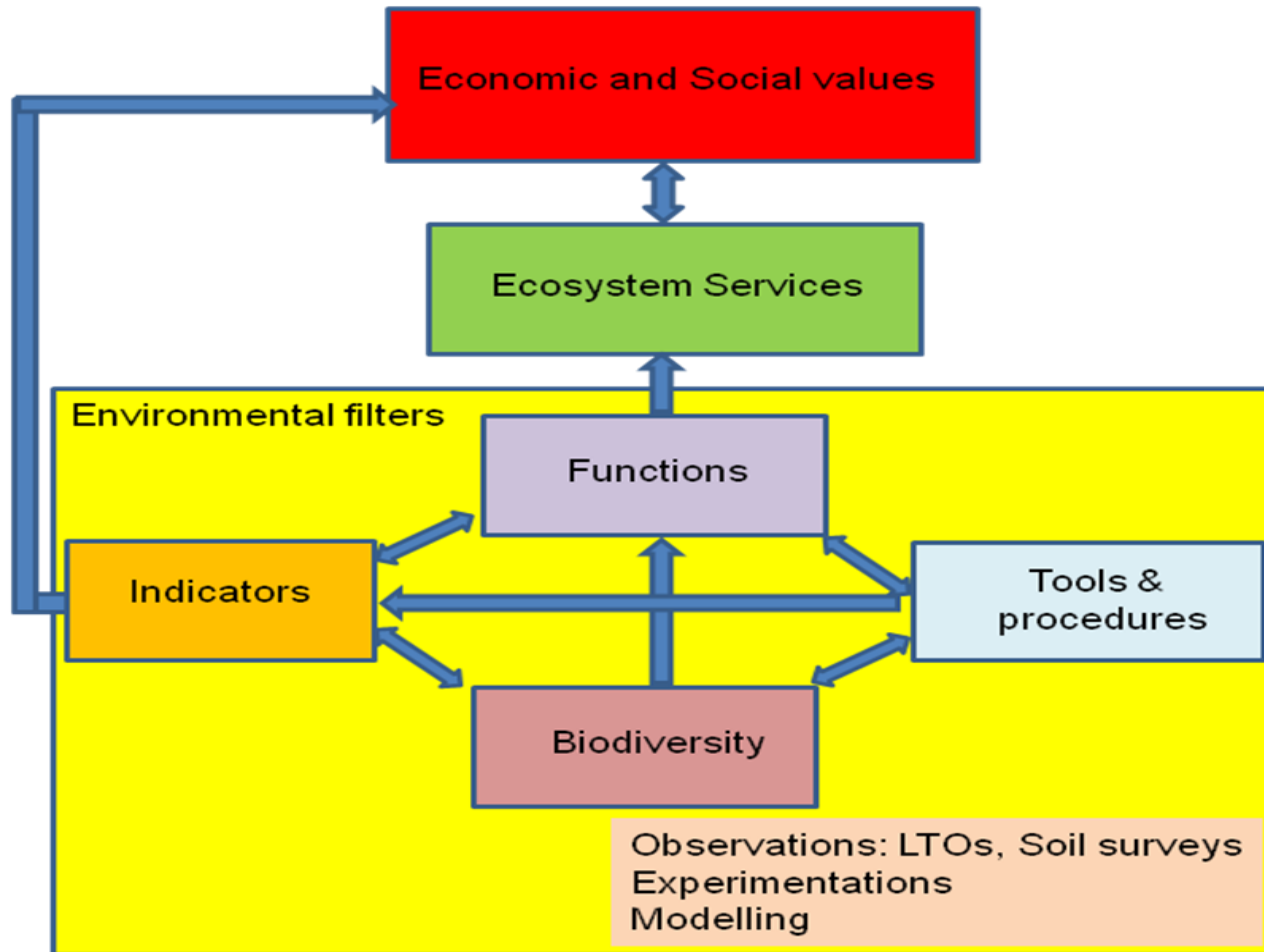
- Long Term Observatories representative of different soil types, climatic zone and land use
- National Soil Surveys – European transect

✓ Experimentation: monoliths,...

✓ Computational ecology

- Soil food web models
- Meta-analysis
- Economic modelling

Strategies



■ 7 Work Packages

- ✓ WP1 - Biodiversity – leader : Mark Bailey (CEH, UK)
- ✓ WP2 – Soil Functioning and Ecosystem Services – leader : Jack Faber (Alterra-DLO, NL)
- ✓ WP3 – Developing and standardising Tools and Procedures for Assessment of Soil Biodiversity – leader Francis Martin (INRA, F)
- ✓ WP4 – Evaluating and Developing Indicators for Biodiversity – leader : Bryan Griffiths (Teagasc, IRL)
- ✓ WP5 – Valuation of Soil Ecosystem Services – leader : Unai Pascual (Cambridge University, UK)
- ✓ WP6 – Dissemination, Technology Transfer and Training – leader Anne Winding (Aarhus University, DK)
- ✓ WP7 – Consortium and Project Management – leader Natasa Pelé (Inra-Transfert, F)

■ 11 Long Term Observatories

- Platforms : GenoSol, Data base management, Bioinformatics, Monoliths...

Standard Operating Procedures

Review of sampling strategies Standardisation of sampling procedures

INTERNATIONAL STANDARD

ISO
23611-1

First edition
2006-02-01

Soil quality — Sampling of soil invertebrates —

Part 1: Hand-sorting and formalin extraction of earthworms

INTERNATIONAL STANDARD

ISO
23611-2

First edition
2006-02-01

Soil quality — Sampling of soil invertebrates —

Part 2: Sampling and extraction of micro-arthropods (Collembola and Acarina)



INTERNATIONAL STANDARD

ISO
10381-1

First edition
2002-12-15

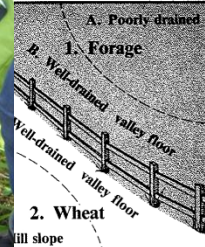
Soil quality — Sampling —

Part 1: Guidance on the design of sampling programmes

take a soil sample... and why

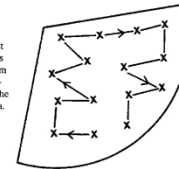
It helps you to develop and maintain a more
oil and to increase returns by providing informa-
available nutrient content of your soil. Soil testing
select the correct kind and amount of fertilizer
material.
Sample weighing approximately 1/2 pound is used to
from 2 to 40 million pounds of soil in the field.
a soil sampling is essential.

sample should represent
soil type or soil condition



A good soil sample should represent the area

- Each sample
should consist
of subsamples
(X) taken from
15 to 20 loca-
tions within the
sampling area.



- Where fertilizer
has previously
been banded, as
for vegetable
crops, take at
least 30 to 40
subsamples.
Don't take sub-
samples from
fertilizer bands
where you can
identify these.

Avoid small, usual areas

Also separate
il samples
on unusual
that are
go enough to
rillize sepa-
tely.

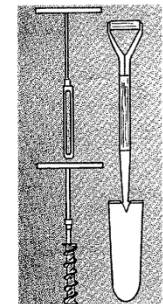


Take soil sample to the correct depth

- Unless otherwise
specified, soil
samples are
taken to plow
depth—usually,
from the surface
down to about 6
to 9 inches.
- When deeper soil
samples are
required,
remove them
from the bottom
of the holes from
which you took
the surface
sample.



Avoid contaminating the sample



- Use clean sam-
pling tools.
- Avoid contam-
inating the sam-
ple during
mixing or
packaging.
- A small amount
of fertilizer resi-
due on tools or
hands, for
instance, can
cause serious
contamination
of the soil sample.
- Galvanized,
brass, or bronze
sampling tools
should not be
used for soil
samples where a
soil test for
micronutrients
such as zinc is to
be run.



Optimisation of DNA extraction

© ISO 2009 – All rights reserved

ISO/TC 190/SC 4

Date: 2009-01-28

ISO/DIS 11063

ISO/TC 190/SC 4/WG 4

Secretariat: NEN

Soil quality — Method to directly extract DNA from soil samples

Qualité des sols — Méthode pour extraire directement l'ADN d'échantillons de sol

- Assessment of possible biases according to the soil type
- Optimisation to allow extraction of DNA of the major types of organisms targeted
 - ✓ Microorganisms (archae, bacteria, fungi)
 - ✓ Fauna (protozoa, nematodes,....)

Standardisation of methods for biodiversity characterization

Definition of bioindicators

- Sensitive
- Consistent – reliable
- Cost-effective

European Transect

European transect based on National soil surveys

environmental
microbiology

Environmental Microbiology (2011)



doi:10.1111/j.1462-2620.2011.02480.x

The bacterial biogeography of British soils

Robert I. Griffiths,^{1*} Bruce C. Thomson,¹
Philip James,^{1,2} Thomas Bell,³ Mark Bailey³ and
Andrew S. Whitteley¹

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UK

³Department of Zoology, University of Oxford, South
Parks Road, Oxford, OX1 3PS, UK

organisms. We conclude that broad scale surveys are
useful in identifying distinct soil biomes comprising
reproducible communities of dominant taxa. Together
these results provide a baseline ecological frame-
work with which to pursue future research on both
soil microbial function, and more explicit biome
based assessments of the local ecological drivers of
bacterial biodiversity.

Introduction

Soils provide a natural habitat for a large number of

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2011) 20, 641–652

RESEARCH
PAPER



Biogeographical patterns of soil molecular microbial biomass as influenced by soil characteristics and management

S. Dequiedt^{1,2}, N. P. A. Saby³, M. Lelievre^{1,2}, C. Jolivet³, J. Thioulouse⁴,
B. Toutain³, D. Arrouays³, A. Bispo⁵, P. Lemanceau¹ and L. Ranjard^{1,2*}

A Belowground Perspective on Dutch Agroecosystems: How Soil Organisms Interact to Support Ecosystem Services

CHRISTIAN MULDER, ALICE BOIT, MICHAEL BONKOWSKI,
PETER C. DE RUITER, GIORGIO MANCINELLI,
MARCEL G.A. VAN DER HEIJDEN, HARM J. VAN WIJNEN,
J. ARIE VONK AND MICHEL RUTGERS

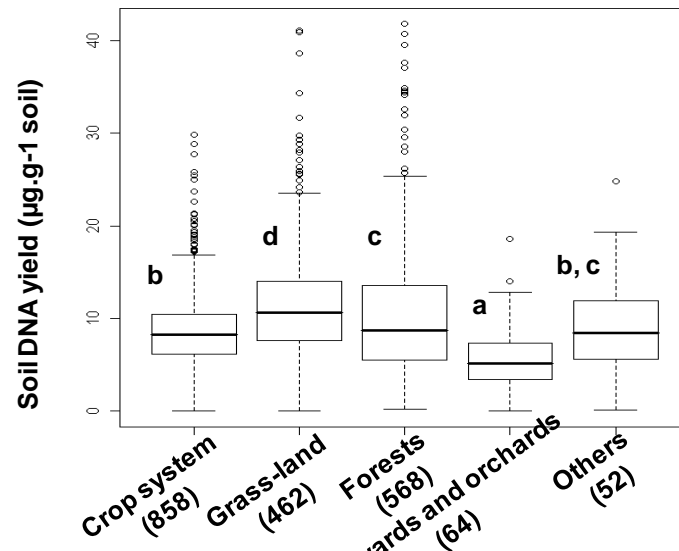
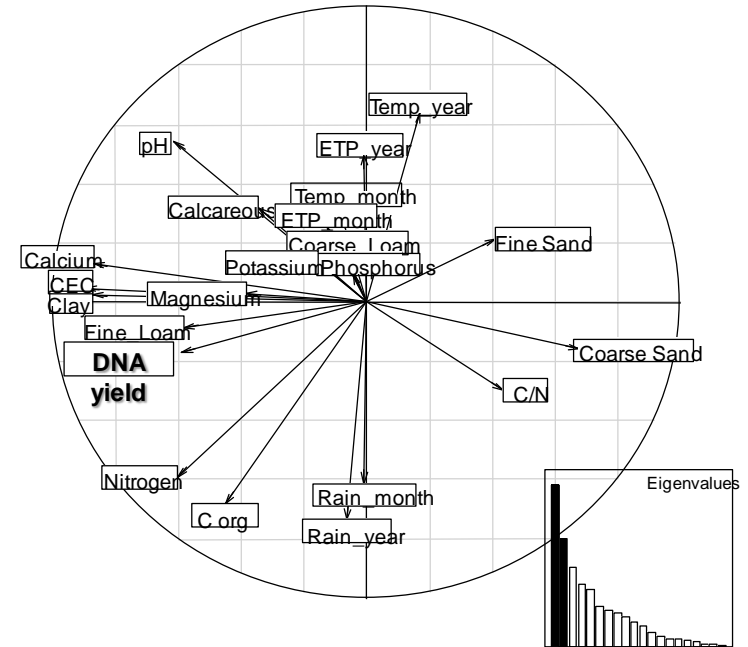
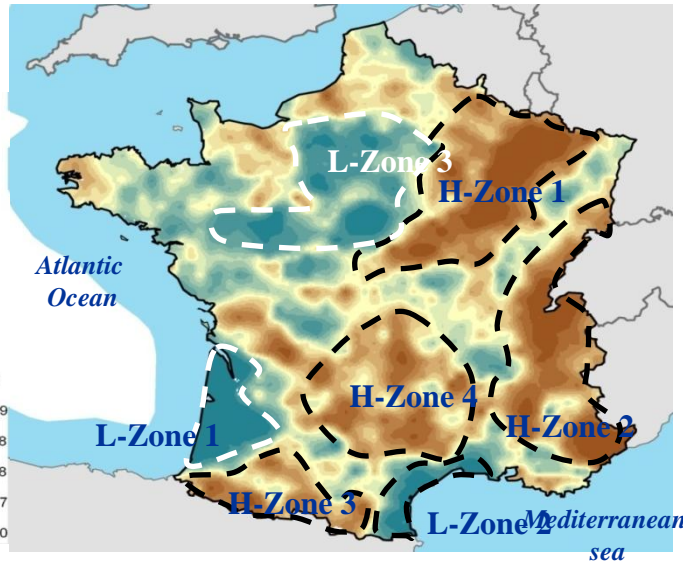
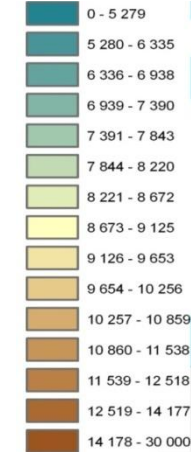
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ADVANCES IN BIOLOGICAL RESEARCH VOL. 44
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0045-204X (11) \$11.00
DOI: 10.1002/advb.11011

European Transect

DNA yield
ng.g⁻¹ soil



➔ Structured distribution of the molecular biomass

➔ There is a need for a referential

➔ Proposition of the concept of 'Normal Operating Range'

Dequiedt et al. 2011. Global Ecol. Biogeogr. 20:641-652.

LTOs = Linking biodiversity & functions & assessment of economic values of ecosystem services

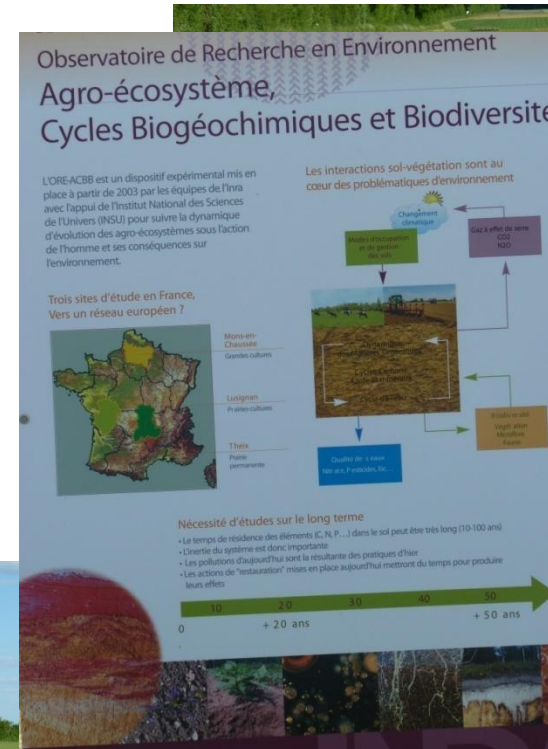
✓ LTOs chosen to cover different climates, soil types, land uses

		Long-term observatories										
		The Cowlands Ireland	ACBB Lusignan France	Tönnersjöheden Siljanfors Sweden	Ultuna Sweden	Berchidda Italy	Network of LTOs China	Veluwe Netherlands	United Kingdom Chronosequence	Châteaurenard France	Hoeven Netherlands	Moskanjci Slovenia
		Long-term observatories' features										
Climates	Atlantic	X	X					X	X		X	
	Boreal			X								
	Continental				X		X					X
	Mediterranean					X				X		
Land use	Arable		X		X	X	X	X	X	X	X	X
	Grass land	X	X			X		X	X			
	Forestry			X		X						
		Ecosystem services and organisms										
Ecosystem services	Nutrient cycling	X			X		X	X	X			X
	Carbon storage		X		X		X	X	X			X
	Water regulation											X
	Soil structure regulation							X	X			X
	Resistance to disease and pests									X	X	
	Above ground diversity regulation	X				X		X	X			
Organisms	Archaea				X		X					
	Bacteria		X	X	X		X	X	X	X	X	X
	Fungi			X	X	X		X	X	X	X	X
	Protozoa		X									
	Nematodes	X						X	X			
	Microarthropods	X		X				X	X	X	X	
	Oligochaeta						X					X



LTOs = Linking biodiversity & functions & assessment of economic values of ecosystem services

- ✓ LTOs chosen for their equipment to measure ecosystem services
- ✓ Ecosystem services addressed
 - Nutrient cycling
 - Carbone storage
 - Structure and water regulation
 - Regulation of above-ground diversity
 - Regulation of diseases



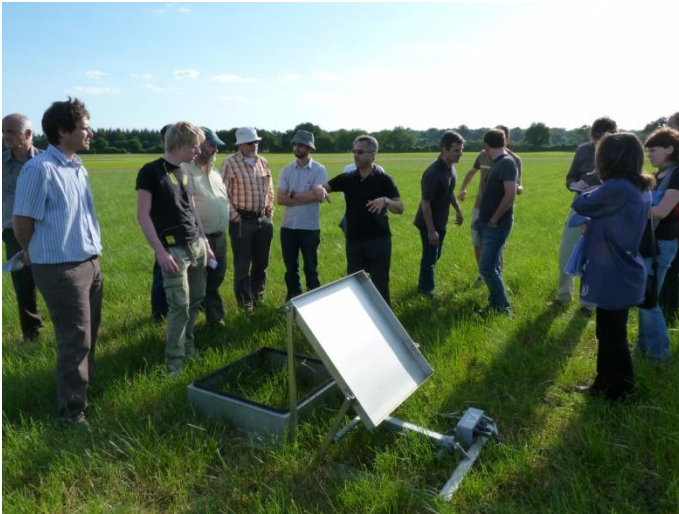
LTOs = Linking biodiversity & functions & assessment of economic values of ecosystem services

✓ For each LTO three intensification levels

↪ Consequences on biodiversity, soil functioning and ecosystem services

✓ Use of chronosequences

↪ relations between initial biodiversity and resistance – resiliency (stability)



Monoliths = Testing hypotheses & indicators

- ✓ Extraction of one or two soils from LTO (UK chronosequence and possibly Bercchida)
- ✓ Application of different abiotic stresses and land use
- ✓ Measurement of consequences on biodiversity and soil functioning
 - ↪ estimation of redundancy
 - ↪ assessment of relations between initial biodiversity and resistance – resiliency (stability)
- ✓ Validation of specificity/sensitivity/applicability of identified bioindicators

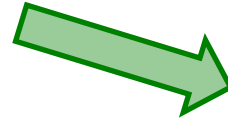


Platform managing large scale samples

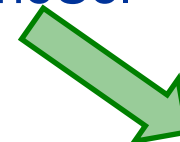
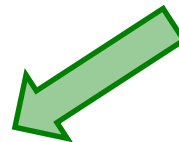
Logistic



Sampling



DNA-theque
(Platform GenoSol – INRA Dijon)



Partners

http://www2.dijon.inra.fr/plateforme_genosol/



Molecular characterization



EcoFINDERS

Expected achievements

■ At the scientific level

- ✓ Increase knowledge of the soil biodiversity (microbes and fauna) across Europe
- ✓ Decipher the relations between soil biodiversity, soil functions and ecosystem services
- ✓ Rank the parameters impacting soil biodiversity and the relation diversity-functions-services

■ At the technological level

- ✓ Standardize methods and operating procedures for characterizing soil biodiversity and functions
- ✓ Develop and validate sensitive, reliable and cost-effective bioindicators
- ✓ Establish a database of soil biodiversity across Europe for application of the 'normal operating range'

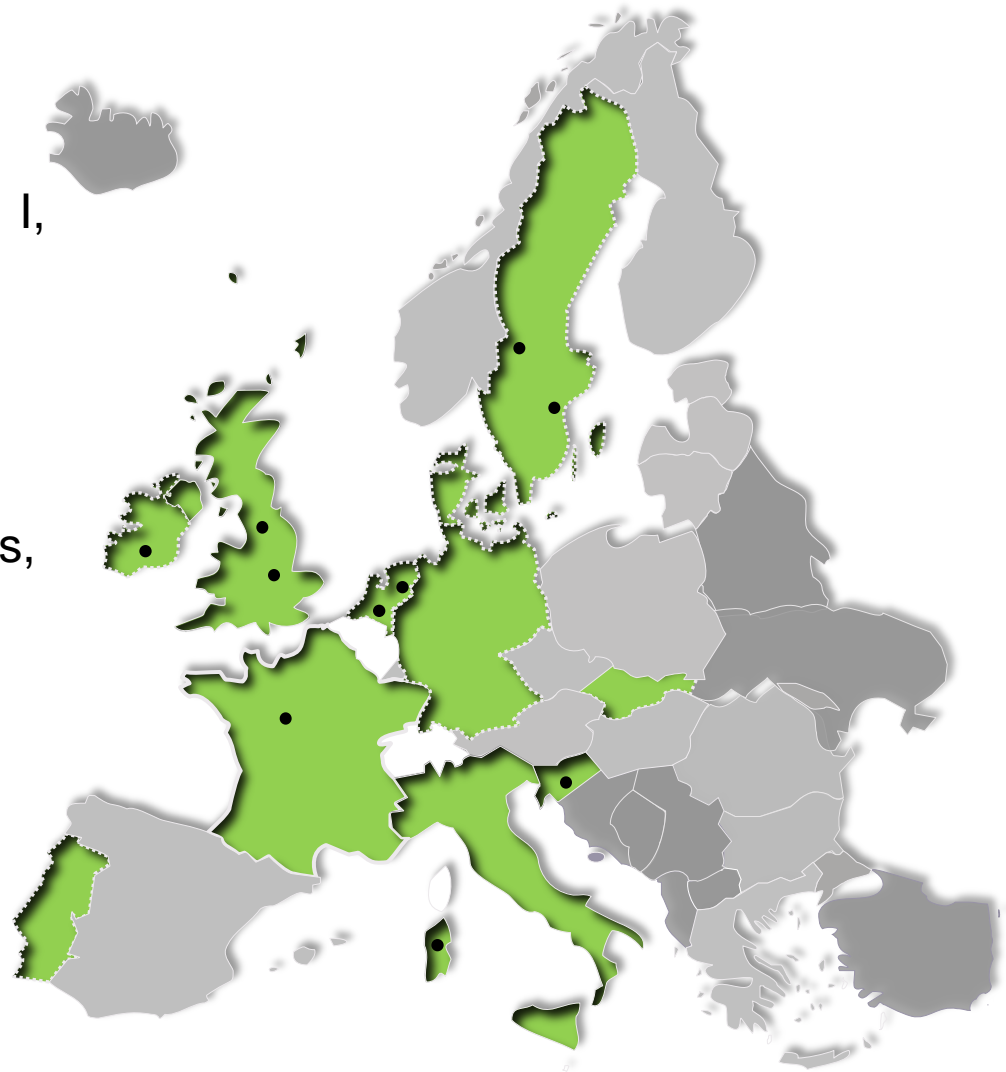
■ At the economic level

- ✓ Assess the economic values of ecosystem services
- ✓ Evaluate the added-value brought by cost-effective bioindicators
- ✓ Assess the cost-effectiveness of alternative ecosystem service maintenance policy




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, oligochaeta



Consortium management



Philippe LEMANCEAU | Log Out

Search in this place



ecofinders > Home

Welcome page

Created By: [Natasa PELE](#) 12/04/2011 15:53:26
Updated By: [Natasa PELE](#) 04/07/2011 16:21:14

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Welcome page

<p> Access to new partners' personal stuff (Post docs,...) click here</p> <p> Link to <i>EcoFINDERS - soil fauna sampling</i></p> <p>Minutes from the FAUNAL SAMPLING PHONE MEETING available here</p>	<p>Click here to accede to the COORDINATOR'S LETTER</p>
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SUBMITTED DELIVERABLES:

WP6 DISSEMINATION, TECHONOLOGY TRANSFERT AND TRAINING

[D6.1: List of stakeholders](#)

[D6.2: Creation of the web site](#)

- Home
- Project information
- Contractual documents
- Deliverables
- Guidelines
- Activity progress reports
- Meetings
- Videoconferences
- Periodic reporting
- Job oportunities
- Publications
- Partners' stuff
- WP1
- WP2
- WP3
- WP4
- WP5
- WP6
- WP7
- LTO's
- TRANSECT
- MONOLITH