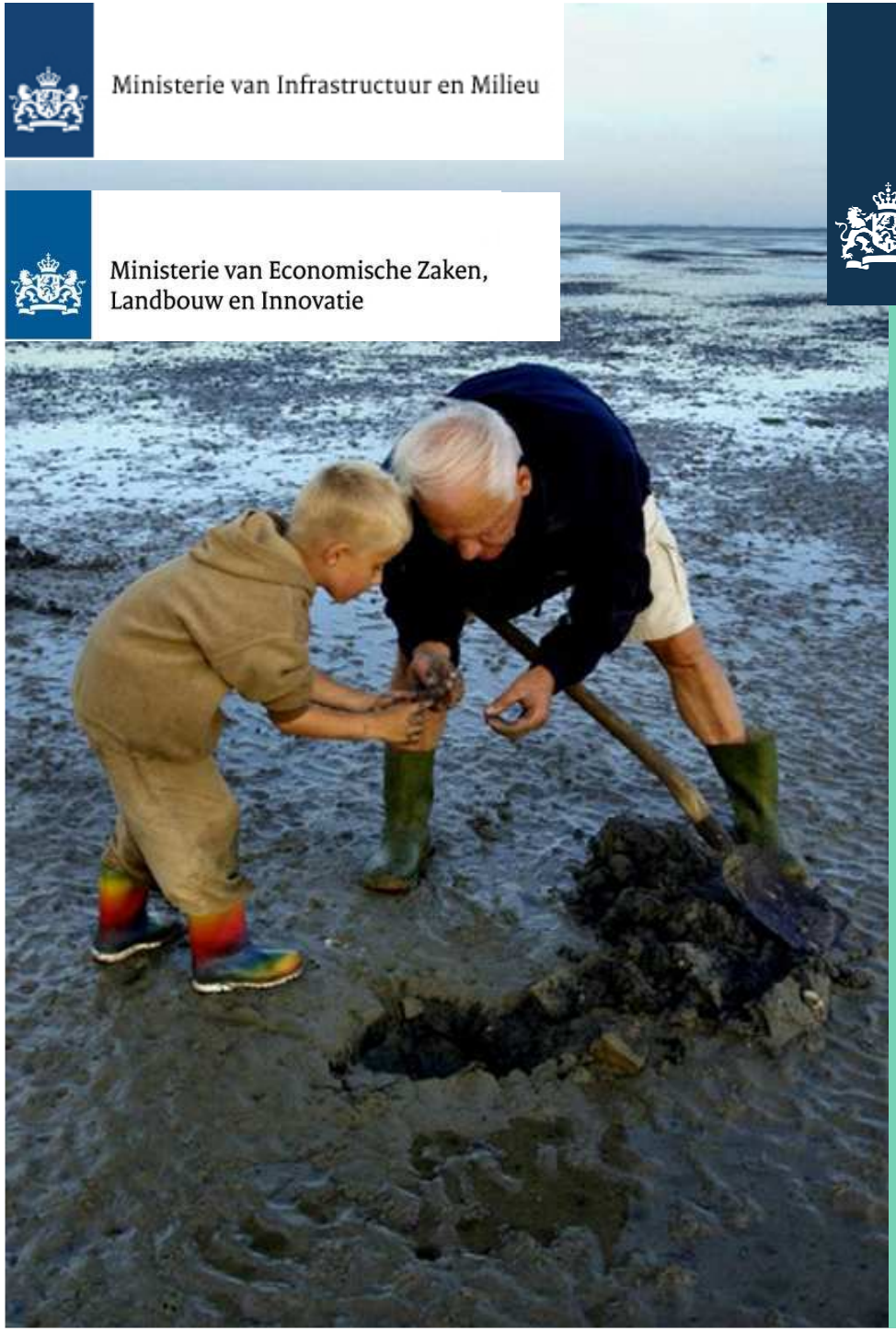
Ministerie van Infrastructuur en Milieu

Ministerie van Economische Zaken, Landbouw en Innovatie



National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

Biological Indicators of Soil Quality (BISQ) in the Dutch Soil Monitoring Network

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BLGG AGROXPERTUS

06 December 2011

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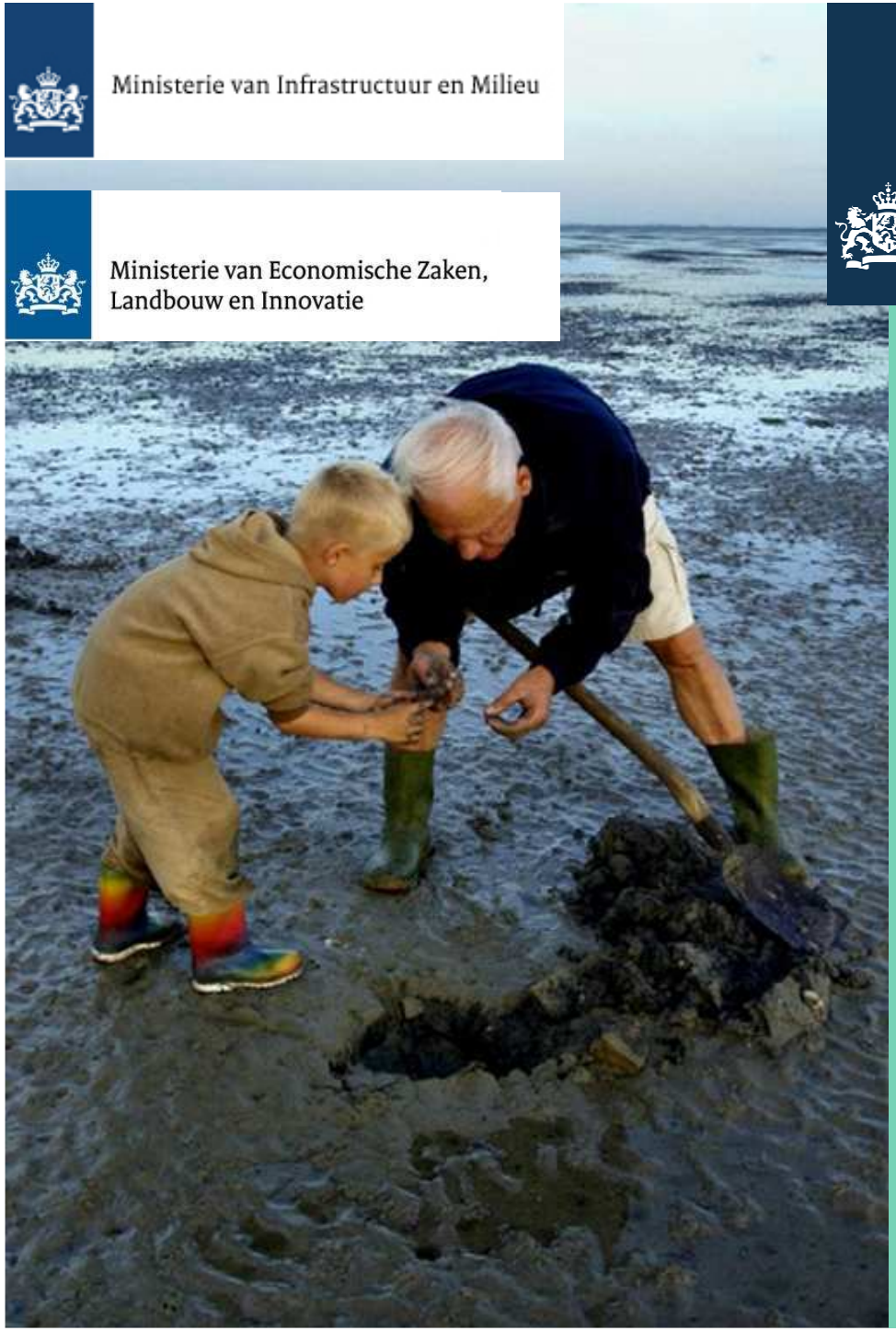

National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

Content

1. Indicators and measurements
2. Data, theory and models
3. Ecosystem services, from theory to practise

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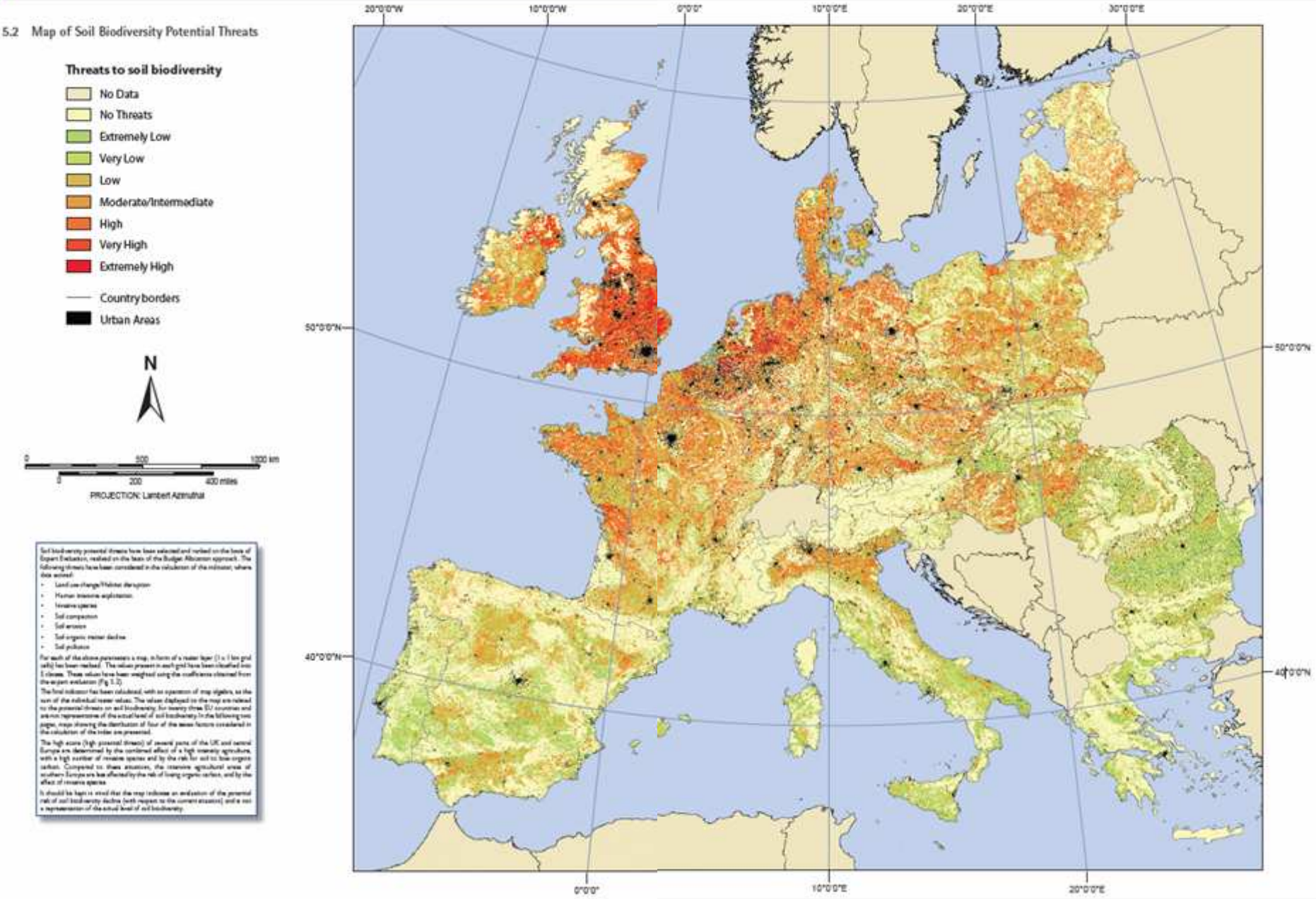
EUROPEAN ATLAS OF

SOIL BIODIVERSITY

JRC
EUROPEAN COMMISSION

5.2 Map of Soil Biodiversity Potential Threats



Soil biodiversity potential threats have been selected and ranked on the basis of Expert Evaluation, realised on the basis of the Budget Allocation approach. The following threats have been considered in the calculation of the indicator, where data existed:

- Land use change/Habitat disruption
- Human intensive exploitation
- Invasive species
- Soil compaction
- Soil erosion
- Soil organic matter decline
- Soil pollution

For each of the above parameters a map, in form of a raster layer (1 x 1 km grid cells) has been realised. The values present in each grid have been classified into 5 classes. These values have been weighted using the coefficients obtained from the expert evaluation (Fig. 5.2).

The final indicator has been calculated, with an operation of map algebra, as the sum of the individual raster values. The values displayed on the map are related to the potential threats on soil biodiversity, for twenty three EU countries and are not representative of the actual level of soil biodiversity. In the following two pages, maps showing the distribution of four of the seven factors considered in the calculation of the index are presented.

The high score (high potential threats) of several parts of the UK and central Europe are determined by the combined effect of a high intensity agriculture, with a high number of invasive species and by the risk for soil to lose organic carbon. Compared to these situations, the intensive agricultural areas of southern Europe are less affected by the risk of losing organic carbon, and by the effect of invasive species.

It should be kept in mind that the map indicates an evaluation of the potential risk of soil biodiversity decline (with respect to the current situation) and is not a representation of the actual level of soil biodiversity.

Concern about loss of biodiversity

Agreement at the Earth Summit in Rio (1992)
→ Convention on Biological Diversity (CBD):
- conservation and sustainable use
- biodiversity; and goods and services through biodiversity

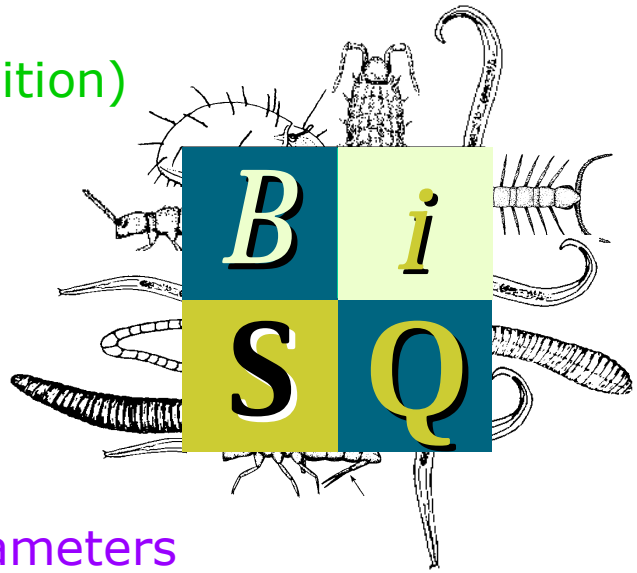
The Netherlands: 70% agricultural area (small nature areas)
→ Strategic Action Plan (SPA, 1994):
- focus on soil organisms and processes (life support functions)
- monitoring in a network → 1997

Life support functions in Dutch soil (1997)

- Decomposition of organic material
  - Fragmentation
  - Transformation of organic substrate
- Cycling of nutrients (N, C, P, S, K, Fe, H_2O)
- Availability of nutrients for plants
- Formation of soil structure
  - bioturbation
  - aggregate formation
- Stability of soil ecosystem and food web

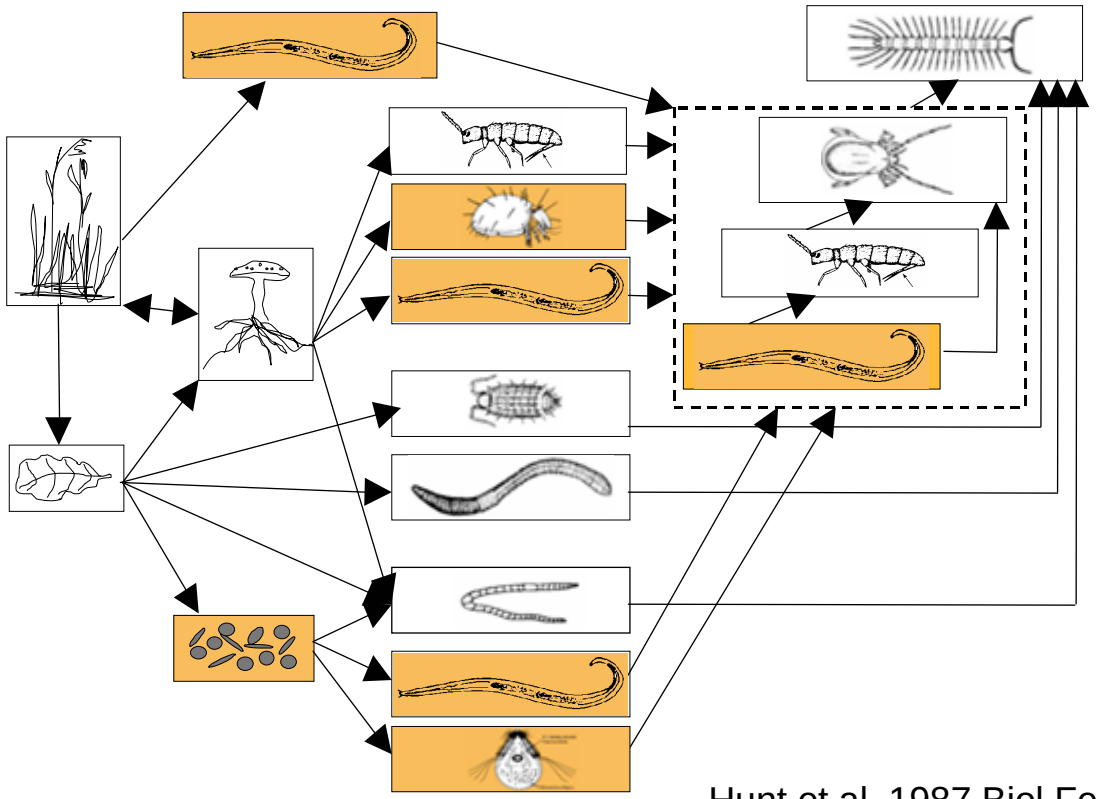
1997 Biological indicator of Soil Quality (BiSQ)

1) Bacteria (several endpoints)
2) Fungi (biomass)
3) Nematodes (community composition)
4) Enchytraeids (idem)
5) Earthworms (idem)
6) Mites and springtails (idem)
7) Processes
8) Organic matter
9) More chemical and physical parameters
10) Vegetation, crops
11) Land management



Schouten et al. 1997. RIVM report 712910005
Schouten et al. 2004. Nem Mon Persp 2:469-482
Rutgers et al. 2009. Eur J Soil Sci 60:820

Organisms interact in food webs



Hunt et al. 1987 Biol Fert Soils 3:57-68
De Ruiter et al. 1995. Science 269:1257-1260

Dutch Soil Quality Network (DSQN)

20 categories:

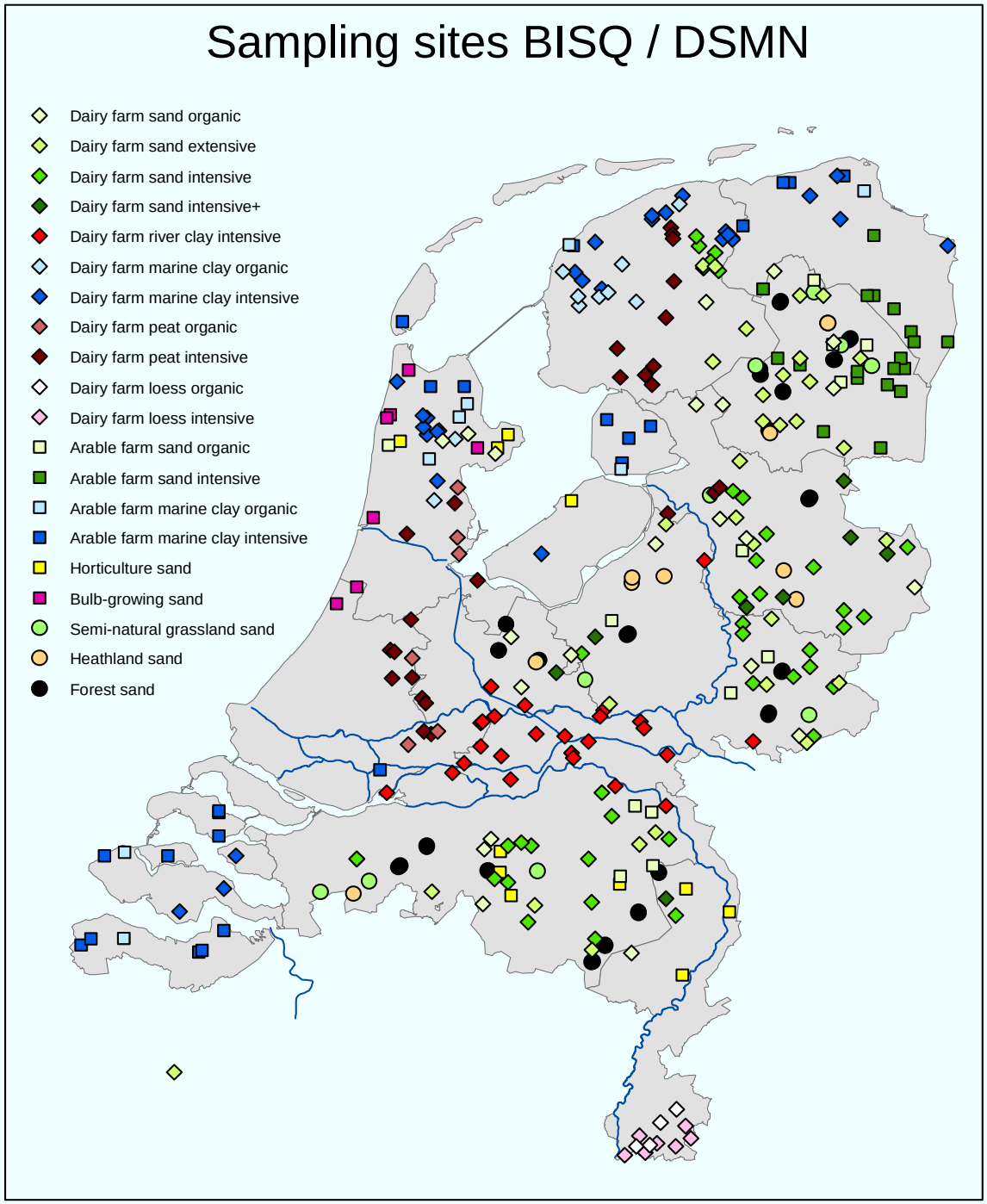
- land use X soil type
- stratified grid; farm level
- represents ~75% surface area Netherlands

Categories:

conventional farms,
organic farms (dairy or arable),
nature, parks

Major soil types:

sand, peat, loess,
marine clay, river clay



Field sampling

Field sampling

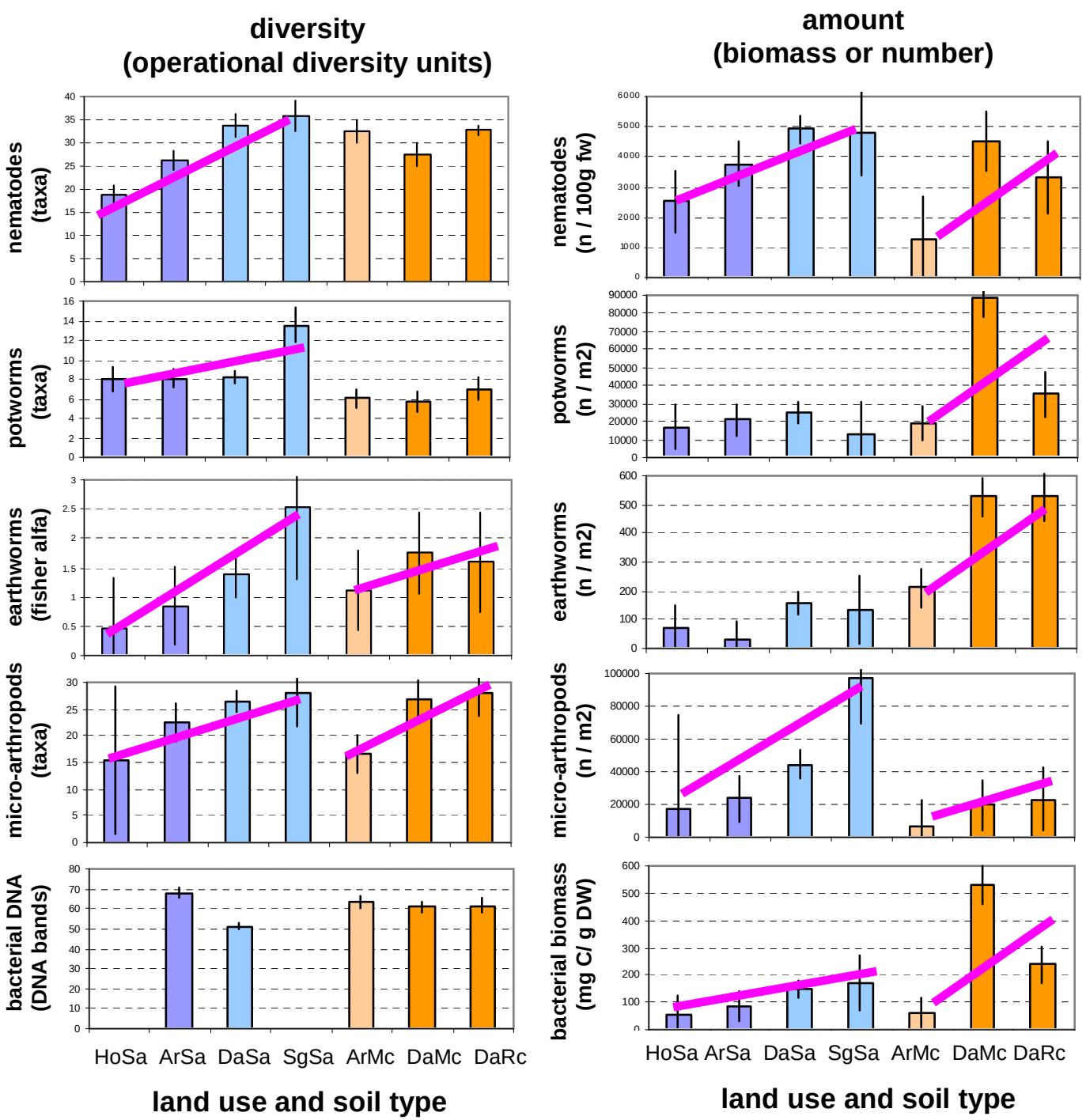
320 cores

Field sampling


Field sampling
6 cubes (20x20x20 cm)

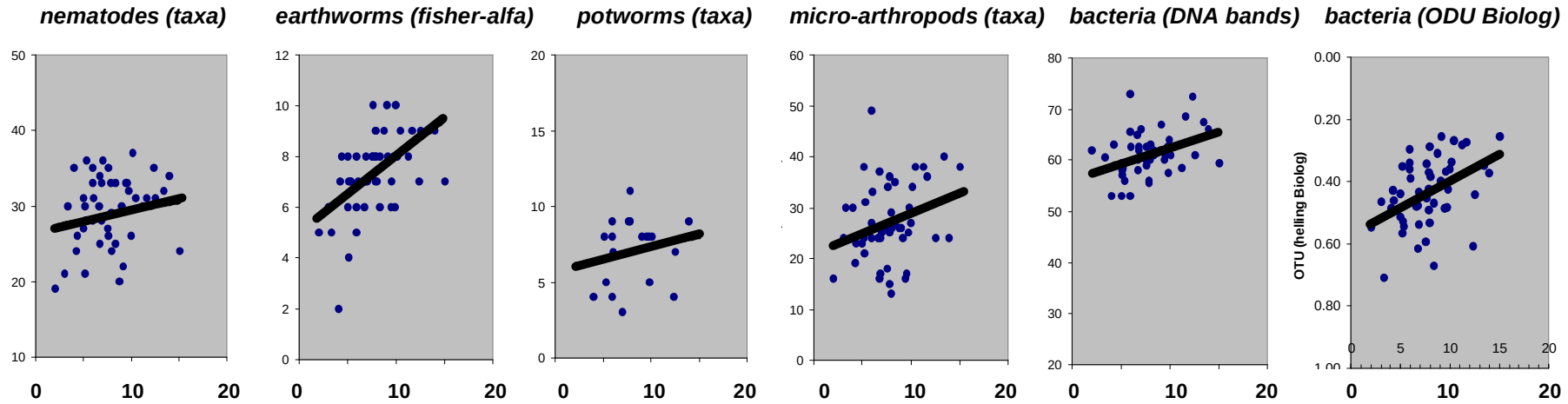
Data

- Many (10^6-10^7)
- >100 pub's
- Variable but realistic

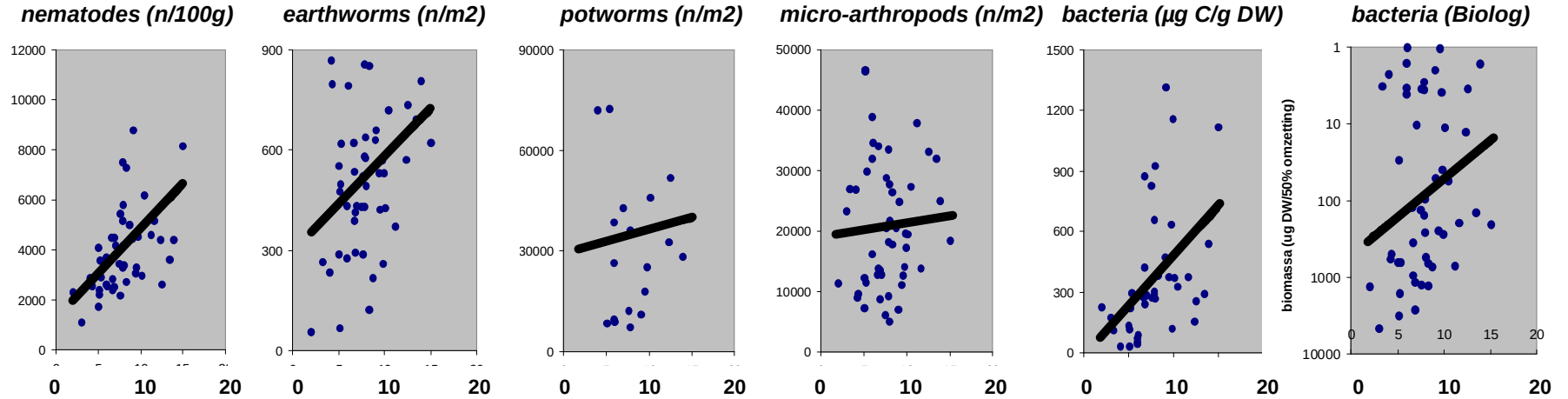


ODU – dairy farming on clay (1999-2003)

Rutgers et al. 2010.
RIVM report 607370002



Biomass – dairy farming on clay (1999-2003)



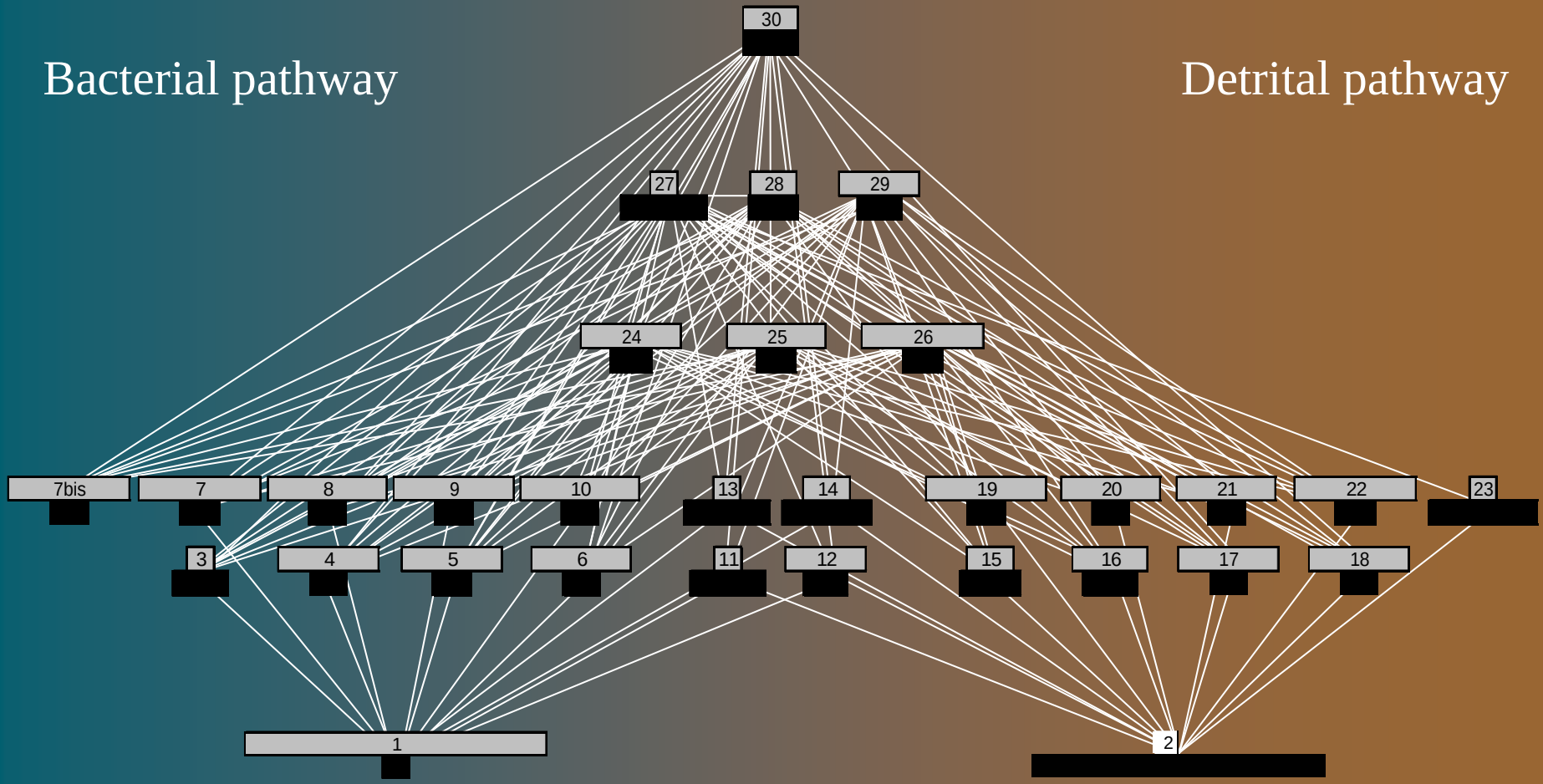
Theory

SOIL SYSTEM

Mulder. 2006. Naturwissenschaften **93:467-479**

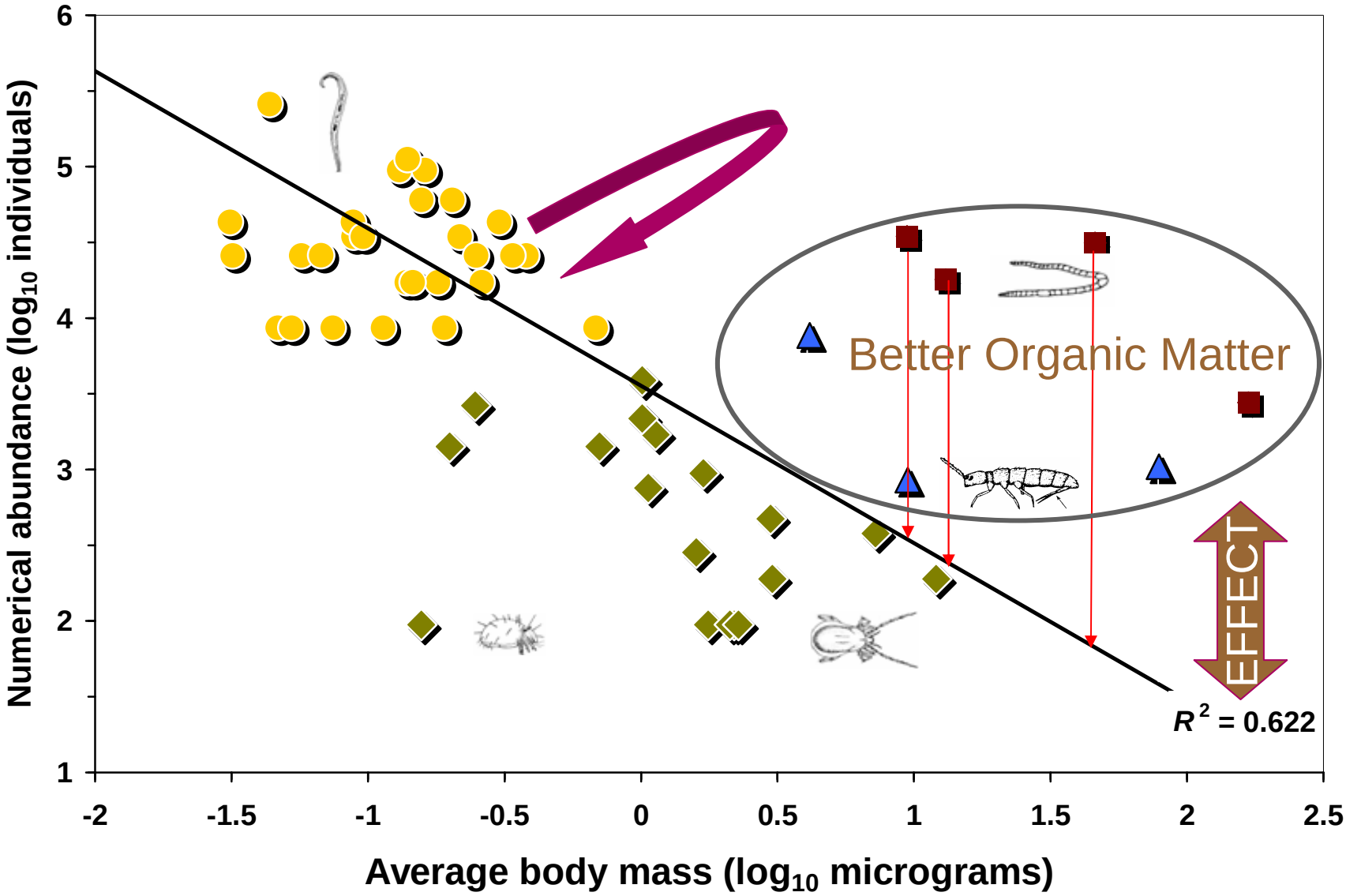
Bacterial pathway

Detrital pathway



SOIL RESOURCES

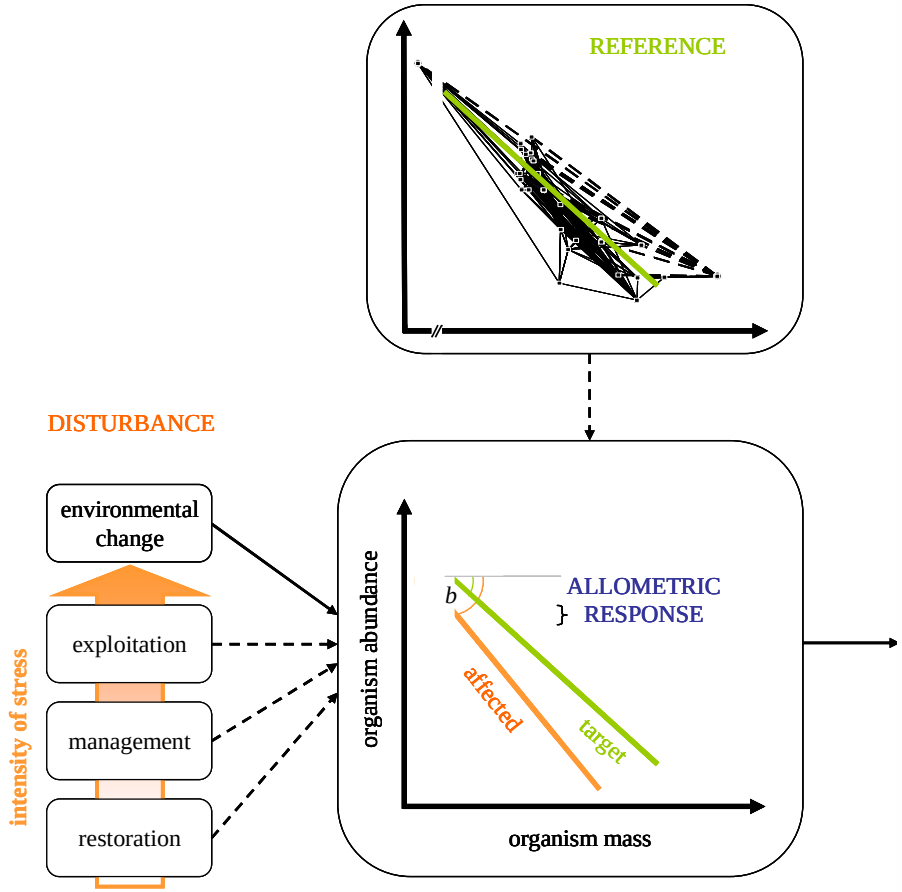
But we can easily merge this huge amount of information in a Cartesian plane

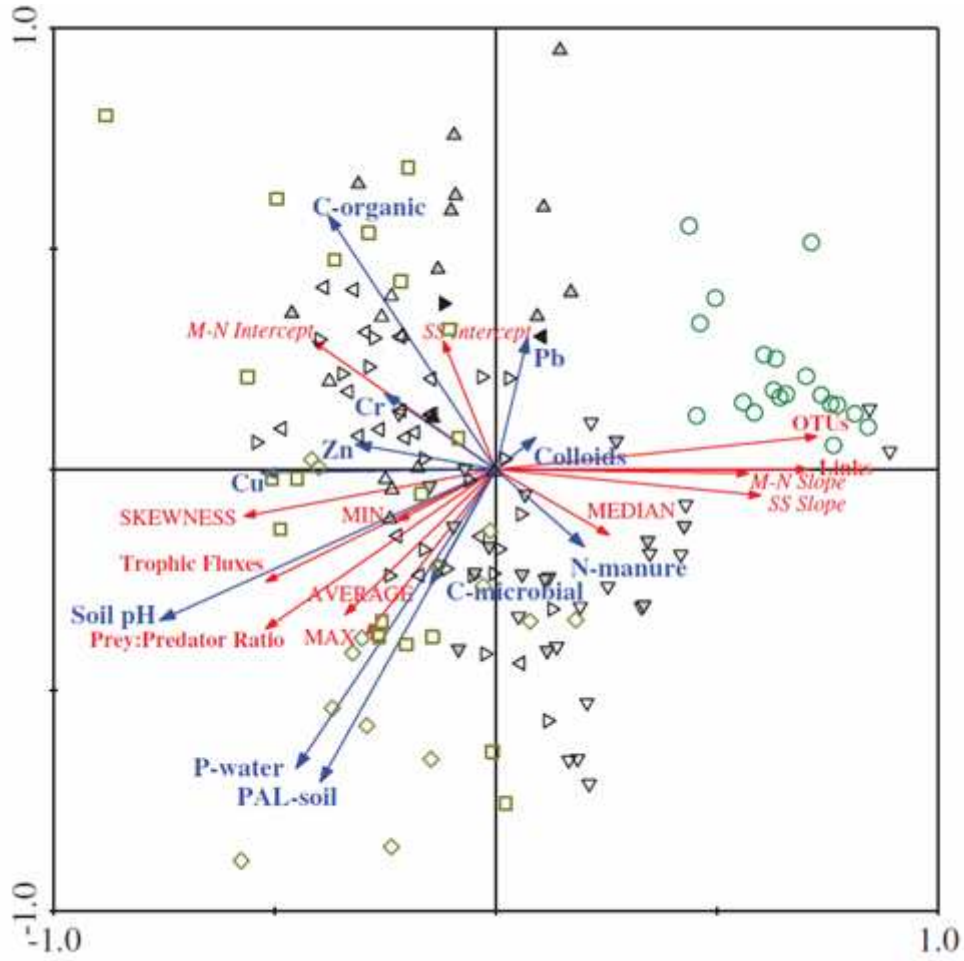


SAME FOOD WEB AS IN THE PREVIOUS SLIDE

Data and assessment

Mulder et al. 2011. Oikos 120:529-536





Ecosystem services (ES)

The benefits from ecosystems

These include products like clean drinking water and processes such as the decomposition of toxic waste.

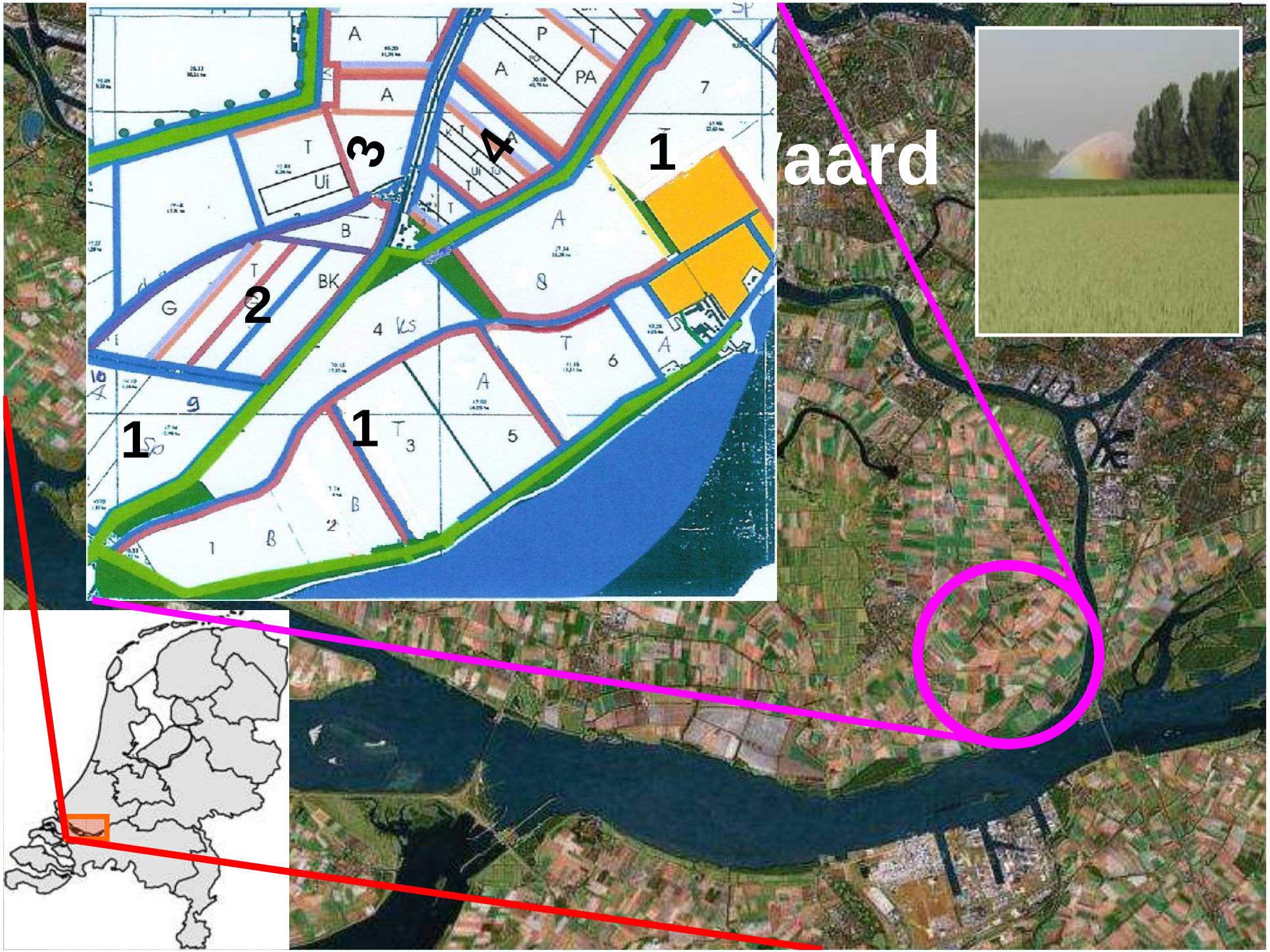
Main categories Millennium Ecosystem Assessment 2005

- Provisioning
- Regulating
- Cultural
- (~~Supporting~~)

Soil organisms provide ecosystem services

Literature and expert judgement, e.g.;
Mulder et al. 2011. Adv Ecol Res 44:277-357
Luck et al. 2009. Bioscience 59:223-235

	SANDY SOILS (PODZOL)	***CLAYS (CAMBISOL AND FLUVISOL)***
Supporting services		
Nutrient cycling	Fungi (1), Lumbricidae (2), Protozoa (3), Enchytraeidae (4), Bacteria (5), Collembola (6)	Enchytraeidae (1), Collembola (2), Fungi (3), Protozoa (4), Lumbricidae (5), Bacteria (6), Nematoda (7), Acarina (8)
Primary production	Fungi (1), Nematoda (2), Lumbricidae (3), Protozoa (4), Bacteria (5), Enchytraeidae (6), Collembola (7), Acarina (8)	Nematoda (1), Enchytraeidae (2), Fungi (3), Protozoa (4), Bacteria (5), Collembola (6), Lumbricidae (7), Acarina (8)
Soil formation	Lumbricidae (1), Enchytraeidae (2), Fungi (3), Bacteria (4)	Enchytraeidae (1), Collembola (2), Bacteria (3), Fungi (4), Lumbricidae (5)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Equations ecosystem services (ES)

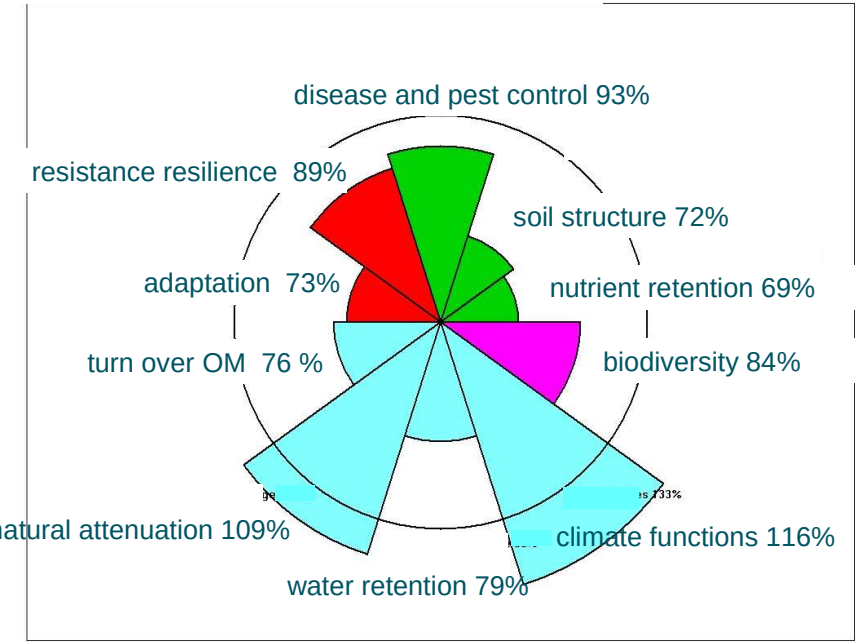
$$\text{soil quality} = \Sigma\ \gamma_{(i)} \cdot ES_{soil(i)}$$

(weight factors $\gamma_{(i)}$ were determined in a multi-stakeholder process)

$$ES_{soil} = f\ (\text{biotics, abiotics, other})$$

10 ecosystem services at 4 arable farms

	average	*A*	*B*	*C*	*D*
1. production related functions					
a. nutrient retention and release	**0.69**	0.64	0.65	0.72	0.70
b. soil structure formation	**0.72**	0.74	0.80	0.65	0.66
c. disease and pest control	**0.87**	1.23	1.05	0.69	0.76
2. resilience and resistance					
a. resistance and resilience	**0.89**	0.93	0.97	0.81	0.74
b. adaptation, land use change	**0.73**	0.77	0.79	0.64	0.62
3. Environmental functions					
a. fragmentation mineralization OM	**0.76**	0.66	0.71	0.73	0.82
b. natural attenuation	**1.09**	1.10	1.05	0.98	1.25
c. water retention	**0.79**	0.78	0.88	0.69	0.77
d. climatic functions (humidity, gasses,..)	**1.16**	1.03	1.16	1.10	1.21
4. biodiversity					
a. habitat function of the soil	**0.84**	0.89	0.90	0.76	0.69



Rutgers et al. 2011.
Sci Tot Environ (in press)

Conclusions and outlook

- Pragmatic choices enable quick and practical quantification of soil quality through the performance of ES:
  - validation of quantification schemes is still requested
  - always do a comprehensive check with all stakeholders for 'forgotten' ES
  - use weight factors to prioritize ES for applications in DSS

- Ecosystem theory is required for quantification of ES;
  not enough is known, but progress is accelerating …..

- Maps can be used in the stakeholder process and for awareness raising

Thanks

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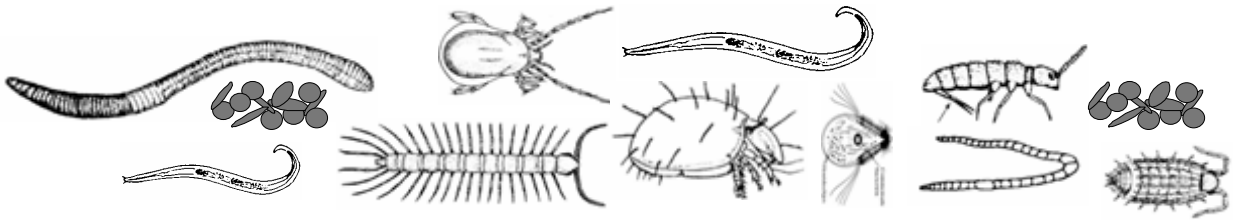

End