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# Opportunities for soil sustainability in Europe

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# This presentation:
# 1. Opportunities for soil sustainability in Europe
# 2. Soil biodiversity

# Pace of activities


2015
International
Year of Soils


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- EU in hiatus since 2014 Soil Directive Withdrawal
- Globally:
  - IYS (2015)
  - IPBES global assessment of land degradation and restoration
  - FAO's Global Soil Partnership
  - G20 summit in Argentina (July 2018) included special meeting on soils
  - current UN and FAO Global Soil Biodiversity Assessment…
- The nexus of actions related to soil sustainability is thus shifting from the EU to the global dimension
- Time for Europe to restore its soil priorities?

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# Everything that we eat, drink, breath, clothes that we wear, and materials that we use pass through soil over and over again

2015
International
Year of Soils

*healthy soils for a healthy life*

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Specialists from 18 European countries
Meeting 21-23 November 2016 at KNAW, Amsterdam
Introductions from EASAC ENV Director and invited speakers

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# The process

- First provide a background document (2 rounds)
- Use that to develop the report in its current shape
- Review by EASAC Environment Steering Panel
- Review by 13 reviewers appointed by the various Academies
- Final approval by Academies
- Presentation in Brussels 26 September 2018

# Outline of the study

**2 The role and importance of soils from recent science**

**3 Soil biodiversity and above-ground biodiversity**

**4 Soils and modern farming**
4.1 Current challenges to soils in farming
4.2 Opportunities in the future Common Agricultural Policy

**5 Soils, plant health and human health**
5.1 Concept of soil ‘health’
5.2 Plant health and food quality
5.3 Soils and human health

**6 Soils and climate change**
6.1 General considerations
6.2 Specific issues on peatlands
6.3 The ‘4 per mille’ initiative

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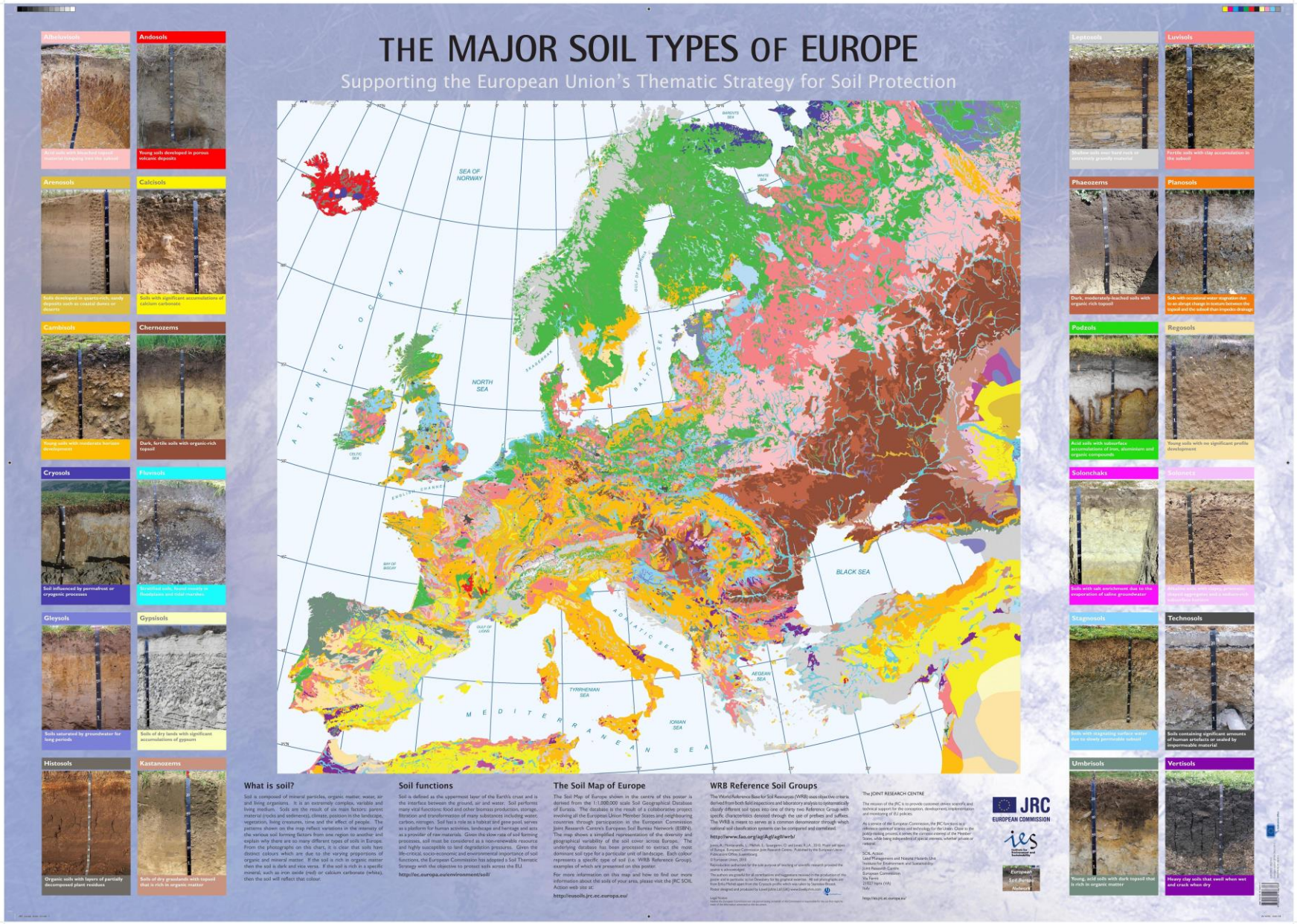
# Introduction remarks

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Soils in Europe are physically and chemically highly diverse

Source:
Soil Atlas of Europe
Jones et al. 2005
JRC ISPRA, Italy

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# “A nation that destroys its soils destroys itself.”

## Franklin D. Roosevelt

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Europe does a good job in this destroying of soils: major risks are erosion, degradation, pollution, mining of sand, gravel, fossil energy, etc.

# Soils and aboveground biodiversity

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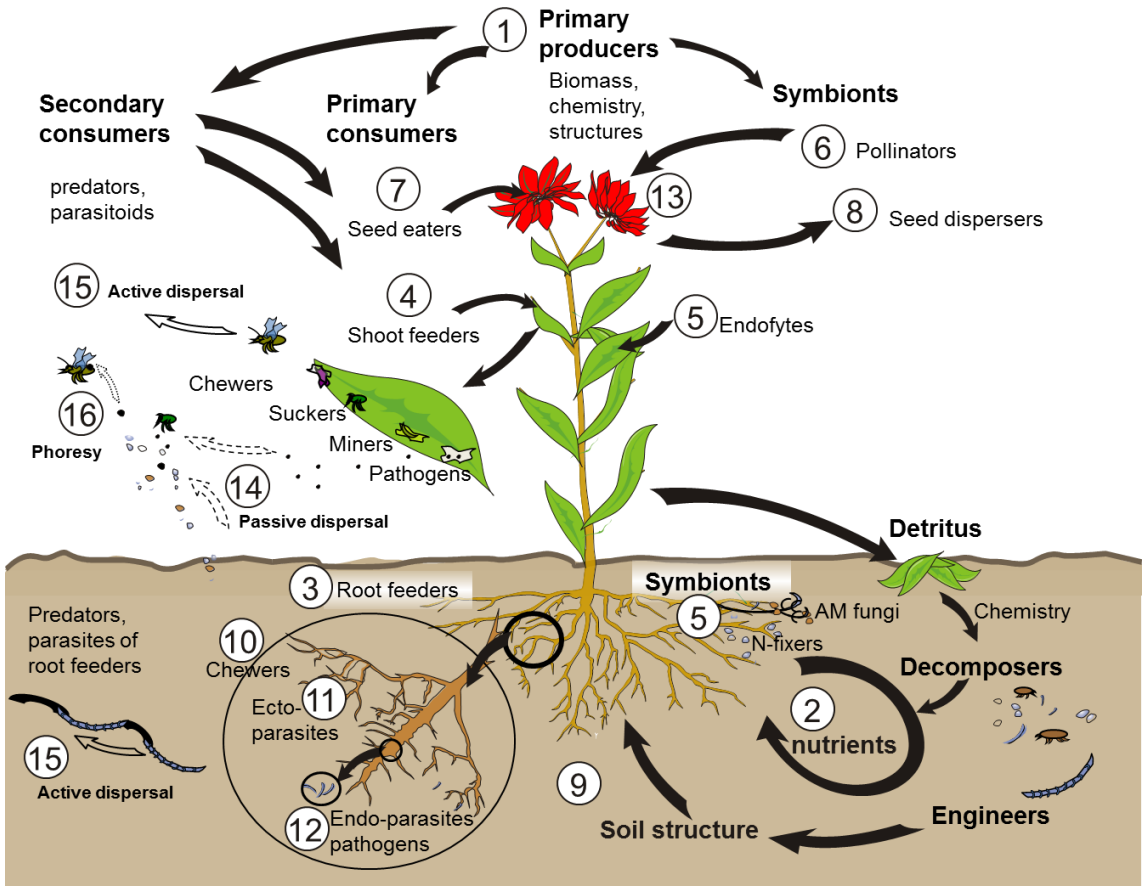


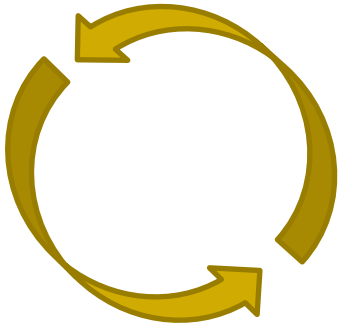

De Deyn, TREE 2005

Soil is the basis for aboveground biodiversity

However: no mentioning of soil biodiversity in Natura 2000 and Habitat Directive

# Soils and modern farming

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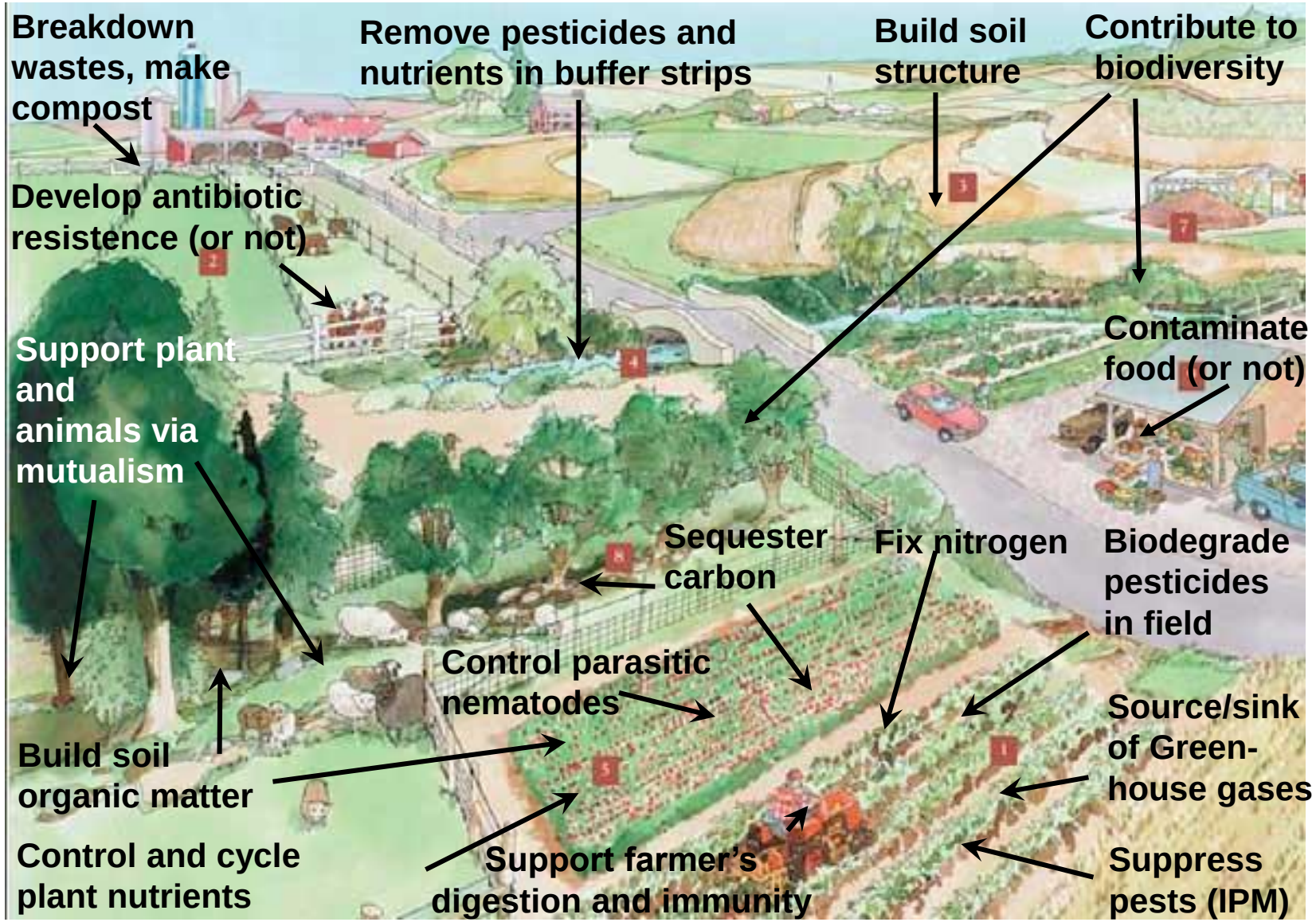


http://images.google.com/imgres?imgurl=http://www.sare.org/publications/explore/images/scenewide2.jpg

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Modern farming reduces soil biodiversity and by-passes natural functions of soil life

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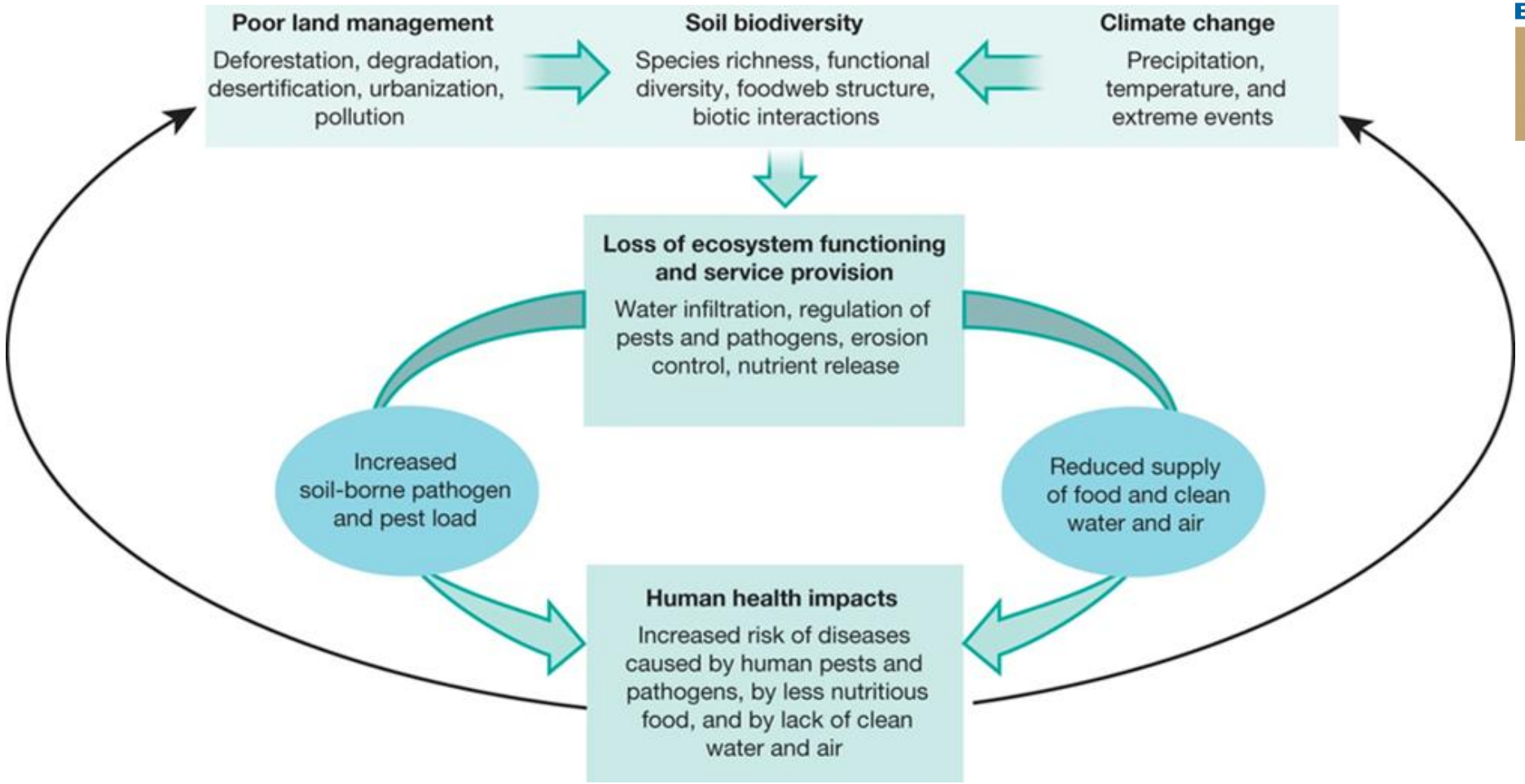
Rothamsted (UK) long-term trials: yields increase,
but crops take up less micronutrients (although still available in soil)

# Socio-economics involved in sustainability: price comparison 1950-2015

| | 1950 | | 2015 | | Factor |
|---|---|---|---|---|---|
| Potato | 0,07 | E/kg? | 0,9 | E/kg? | 13 |
| Bread | 0,17 | E/bread | 1,19 | E/bread | 7 |
| Agricultural soil | 2500 | E/ha | 50000 | E/ha | 20 |
| Harvest winter wheat | 4 | ton/ha | 12 | ton/ha | 3 |
| Price wheat | 800 | E/ton | 100 | E/ton | 0.125 |

Source: http://statline.cbs.nl/

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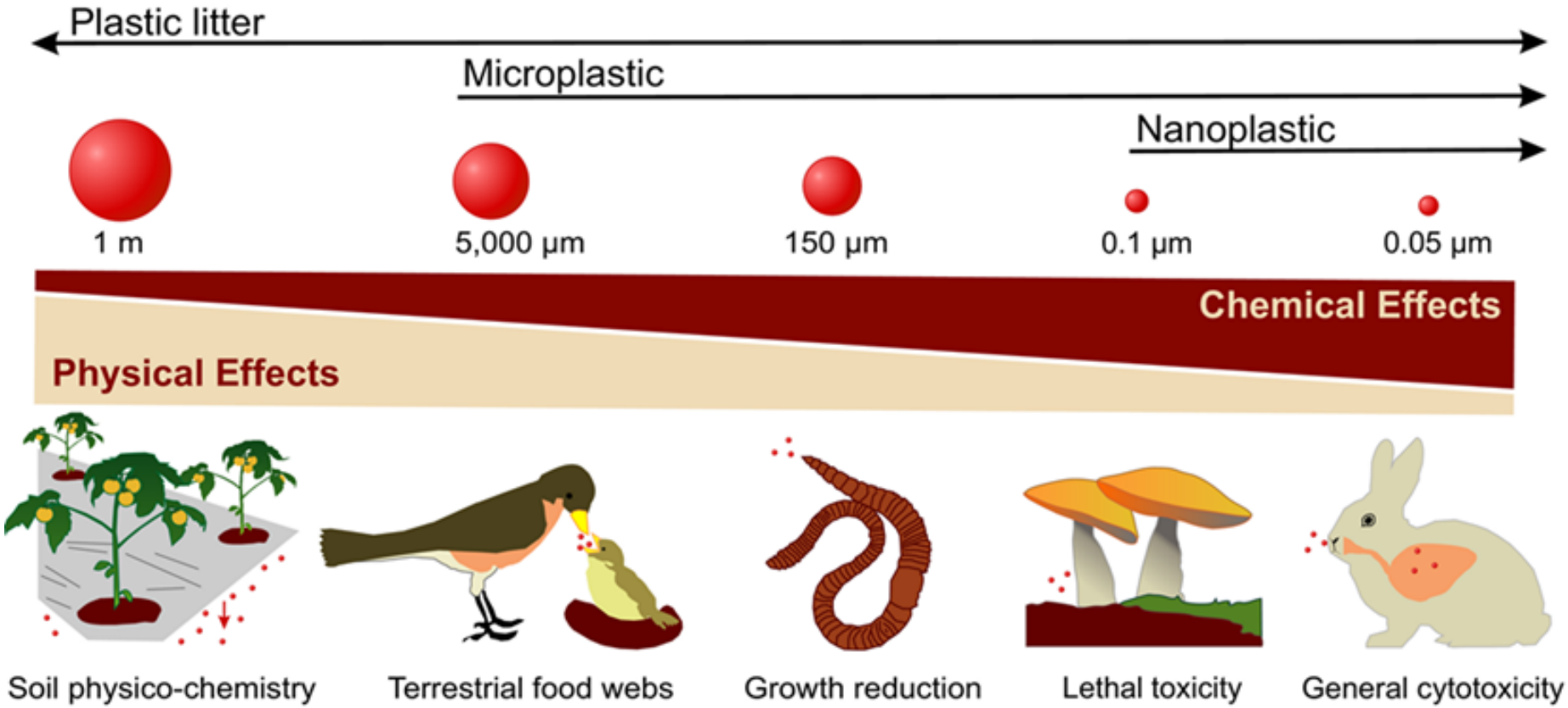
# Soil and plant / human health

Wall et al. 2016 Nature

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# New threat: (micro)plastics in soil

Machado et al. 2018 Global Change Biology

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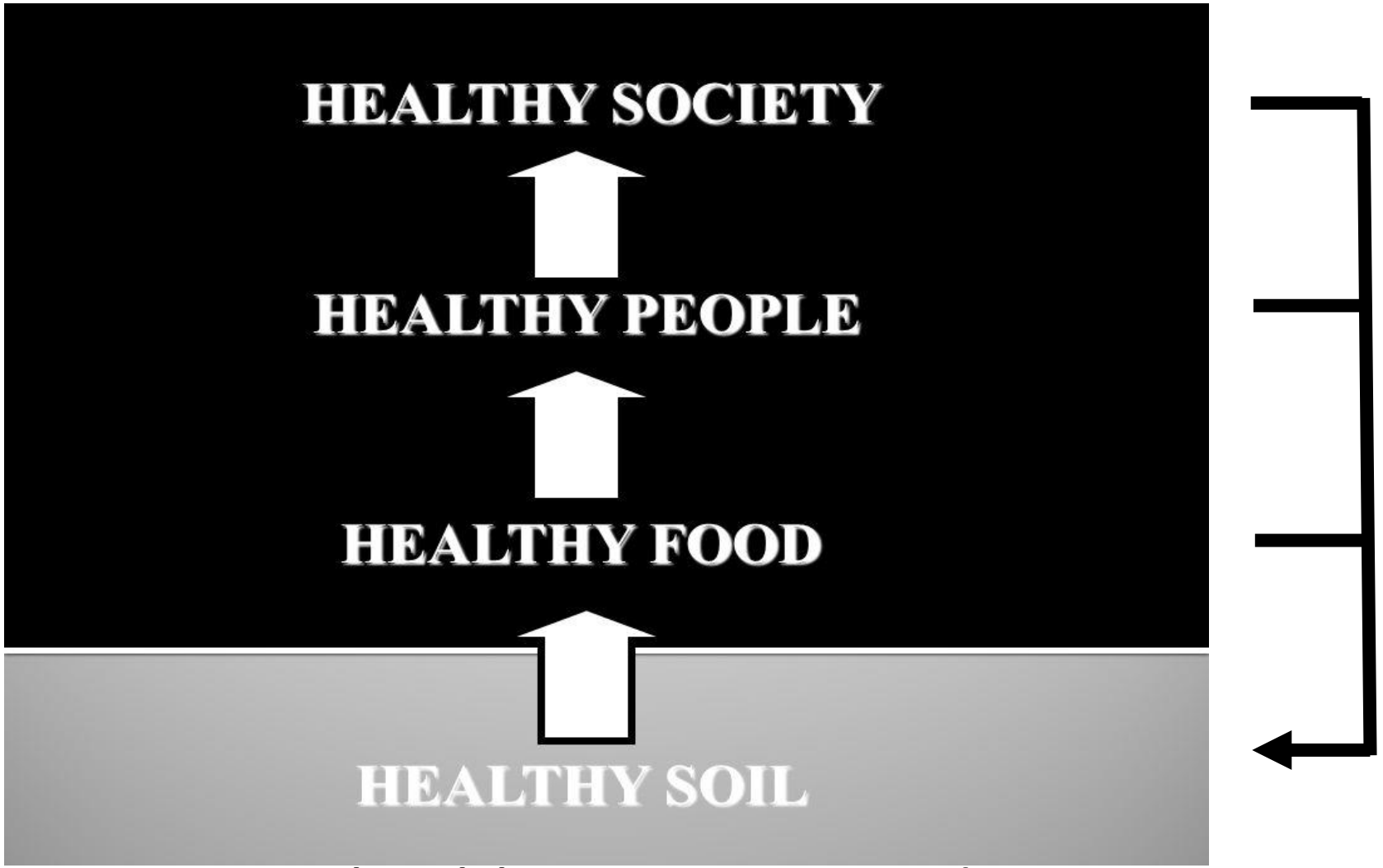


One-health concept provides unexplored opportunities!

Adapted from: George Kuepper The Kerr Center for Sustainable Agriculture

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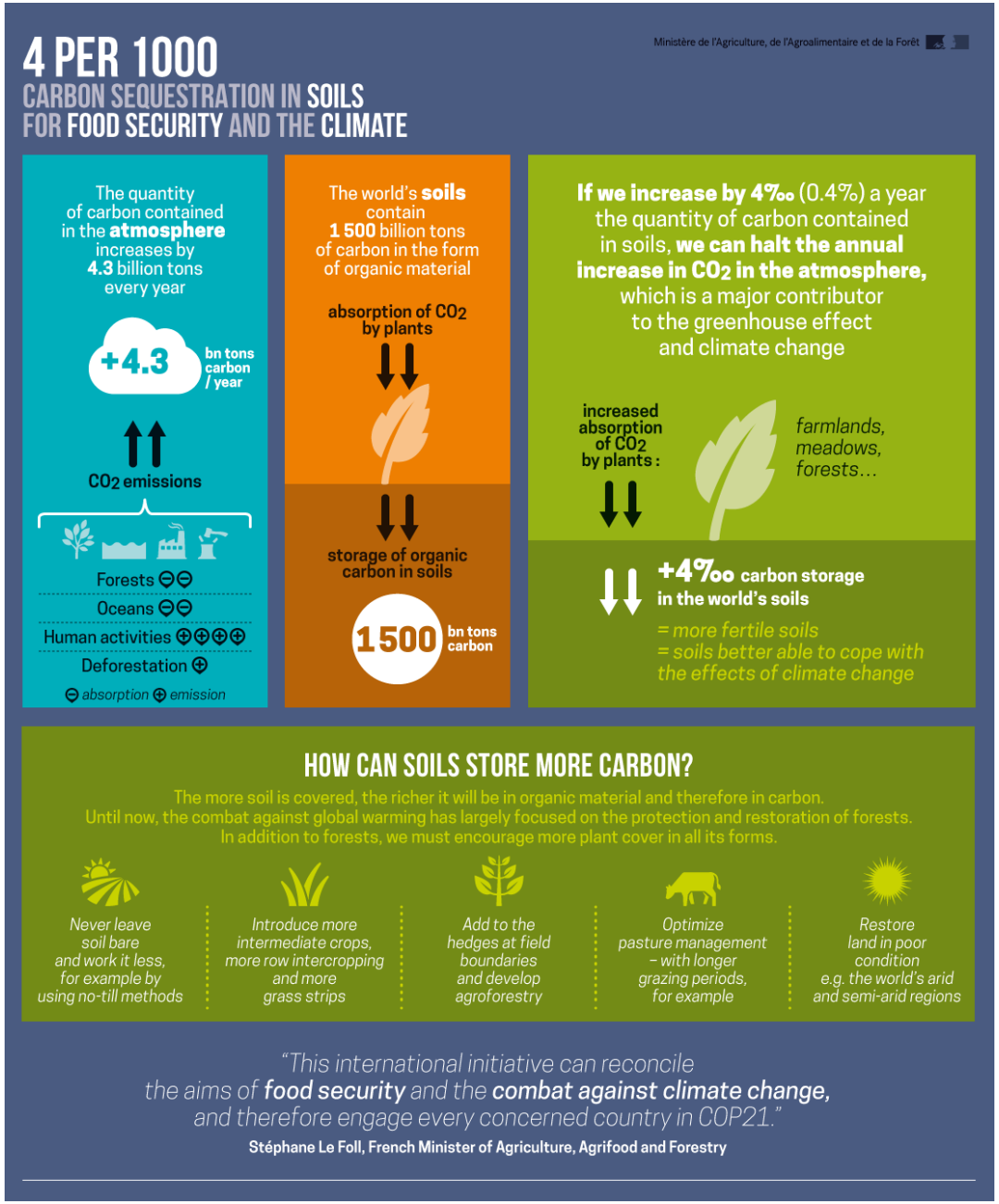
# Climate control and consequences of climate change

## *Some figures*

- Since start of agriculture (12,000 years ago) soils have lost 133 billion tonnes of carbon to atmosphere.
- Currently, there is still appr. 70-75 billion ton carbon left in European soils.
- Soil organic carbon is being lost at a rate equivalent to 10% of the total fossil fuel emissions for Europe .
- To support COP 21, carbon levels should become restored in soil.

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## Following COP 21: 4 per mil initiative

- Is overoptimistic
- Should not prevent taking other measures

But: is no-regret approach and should therefore be supported

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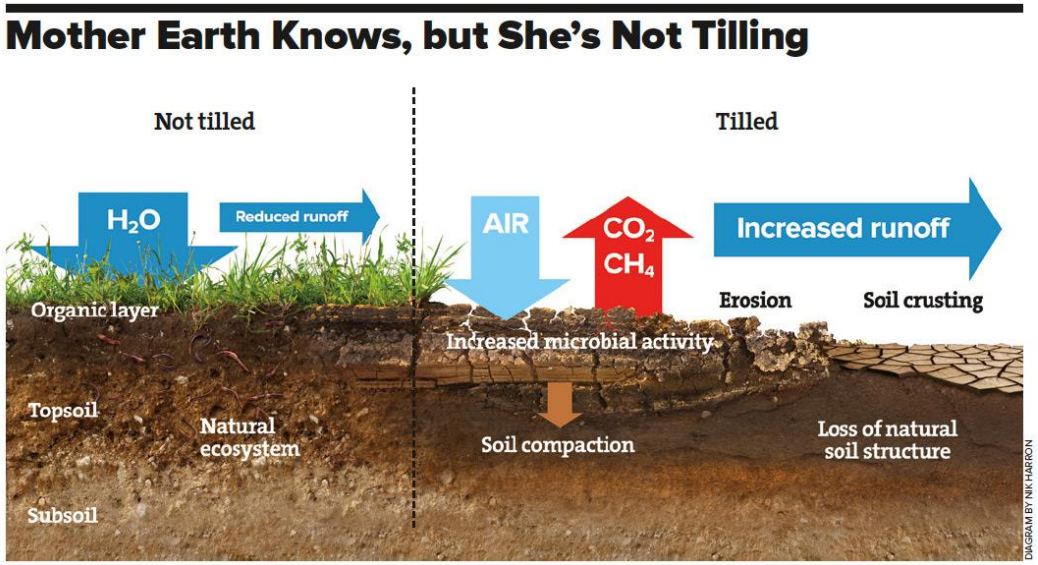
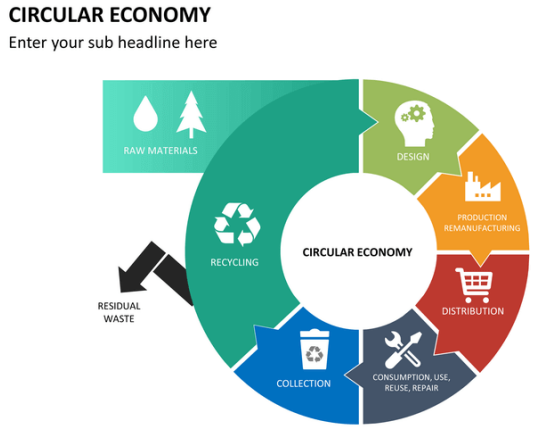
Keep carbon where it is (peatlands)




Prevent carbon loss by excessive tilling

Promote carbon storage and closing cycles




Promote circular economy

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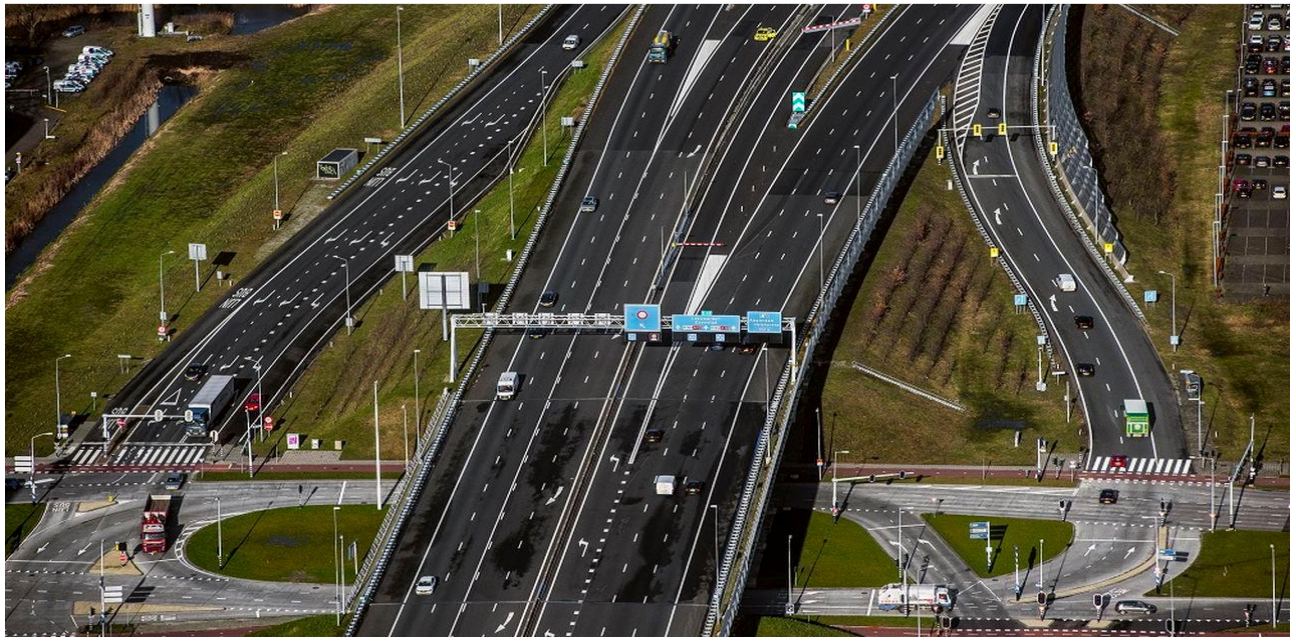
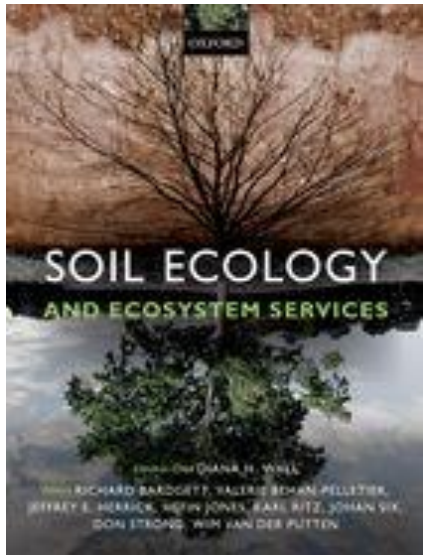


Urbanization in Europe: in 10 years size of Luxembourg urbanized


Soil Biodiversity synthesis report February 2010
http://ec.europa.eu/environment/soil/biodiversity.htm





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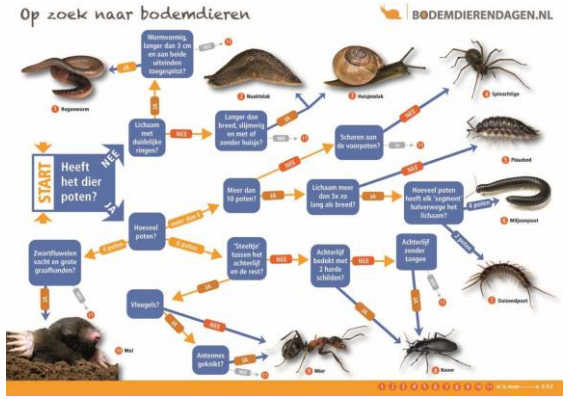


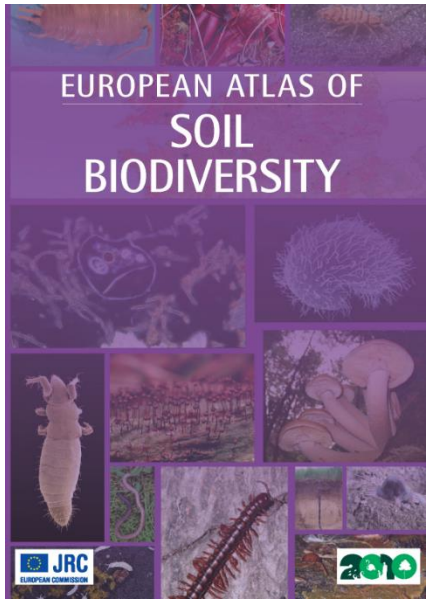


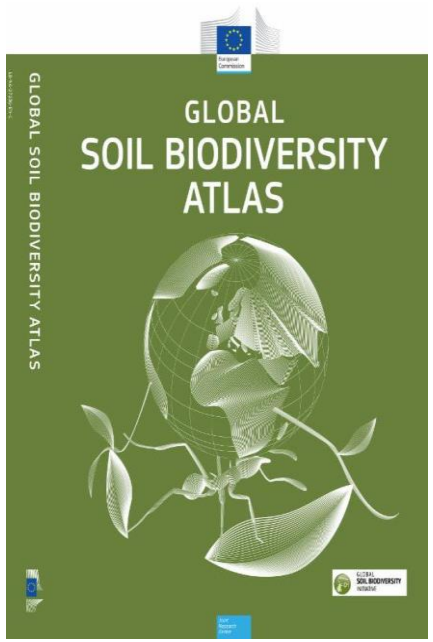


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Education and independent extension services needed

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# Soil Biodiversity

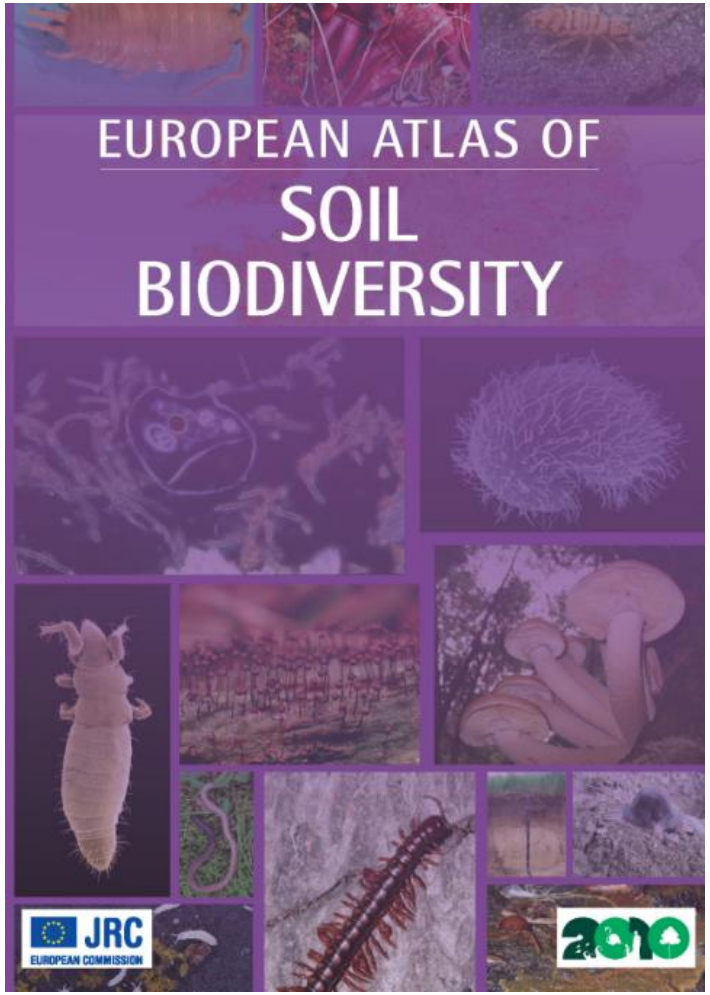
A hand full of soil: over 5,000 ‘species’ of microbes,
more individuals than humans on earth, more than 100 m fungal hyphae.

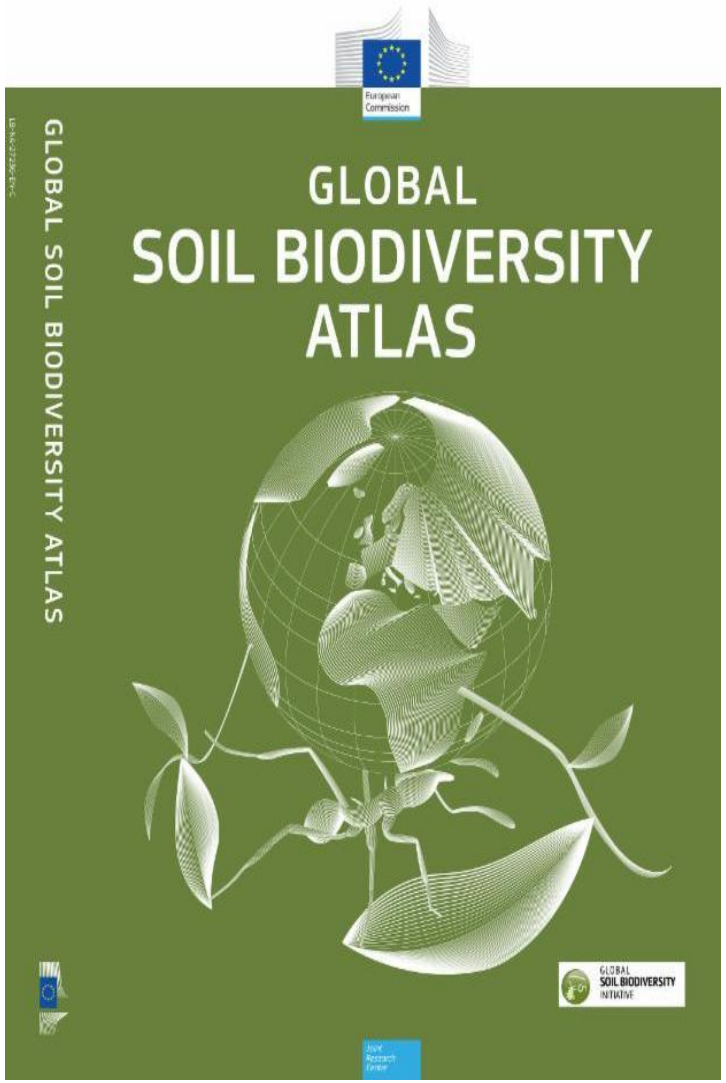

Bardgett and van der Putten Nature 2014

# Estimated diversity and abundance of soil taxa according to published literature, supported by expert judgment.

| Taxon | Diversity per amount soil or area (taxonomic units indicated below) | Abundance (approximate) |
|---|---|---|
| Prokaryotes[a] | 100-9,000·$cm^{-3}$ | 4-20·$10^{9}$·$cm^{-3}$ |
| Fungi[b] | 200 $m.g^{-1*}$ | 100 $m.g^{-1}$ |
| AMF (species) [c] | 10-20 $m^{-2}$ | 81-111 $m.cm^{-3}$ |
| Protists[d] | 150-1,200 (0.25 $g)^{-1**}$ | $10^{4}$-$10^{7}$·$m^{-2}$ |
| Nematodes (genera)[e] | 10-100 $m^{-2}$ | 2-90·$10^{5}$ $m^{-2}$ |
| Enchytraeids[f] | 1-15 $ha^{-1}$ | 12,000-311,000 $m^{-2}$ |
| Tardigrades[g] | ? | ? |
| Collembola[g] | 20·$m^{-2}$ | 1-5 $10^{4}$ $m^{-2}$ |
| Mites (Oribatida) [h] | 100-150 $m^{-2}$ | 1-10 $10^{4}$· $m^{-2}$ |
| Isopoda[g] | 10 ·100 $m^{-2}$ | 10 · $m^{-2}$ |
| Diplopoda[g] | 10 ·2,500 $m^{-2}$ | 110 · $m^{-2}$ |
| Earthworms (Oligochaeta)[i] | 10-15 $ha^{-1}$ | 300 · $m^{-2}$ |

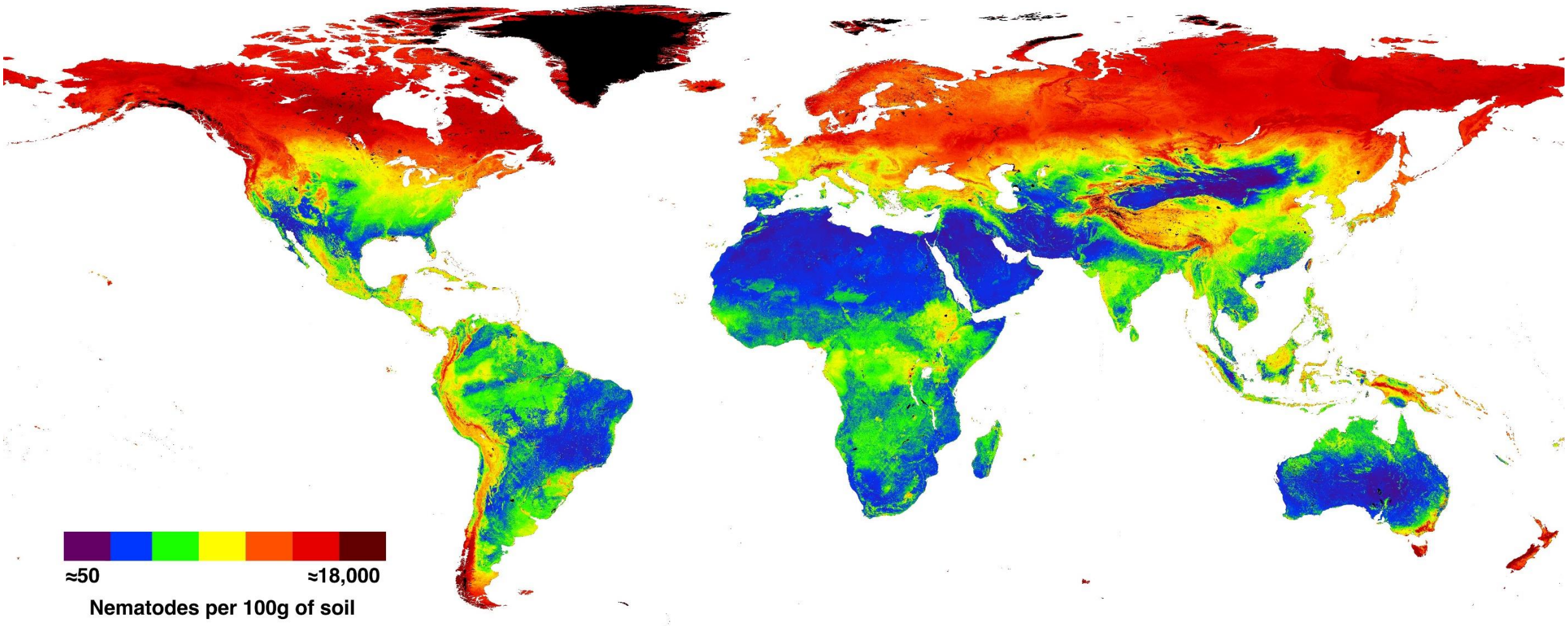
Bardgett and van der Putten Nature 2014




Global soil biodiversity Assessment
(2020 COP Beijing)

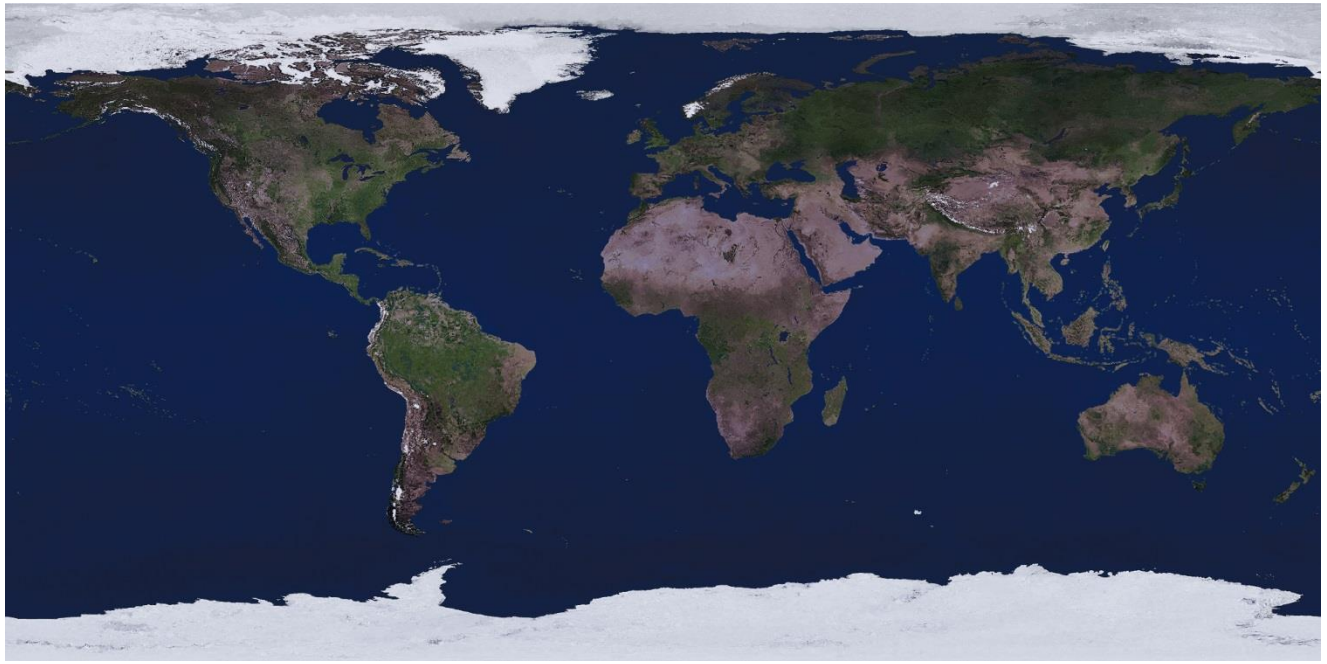
Under development




# Global nematode survey

Van den Hoogen, Geisen et al. Nature 2019

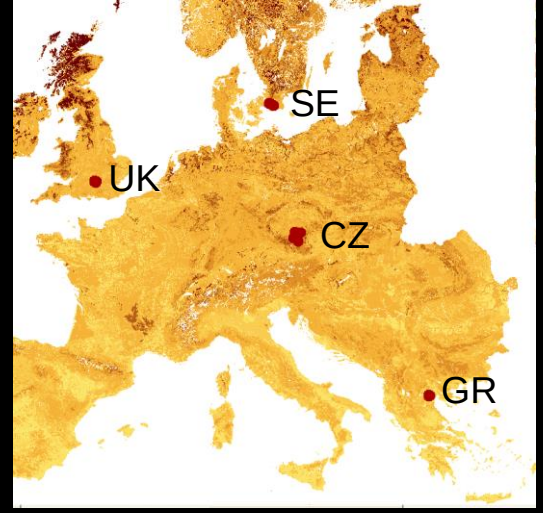

Who
Does
What



When and where

Unbearable
lightness
of being
in soil….

# SOILSERVICE




tillage

at most every two years

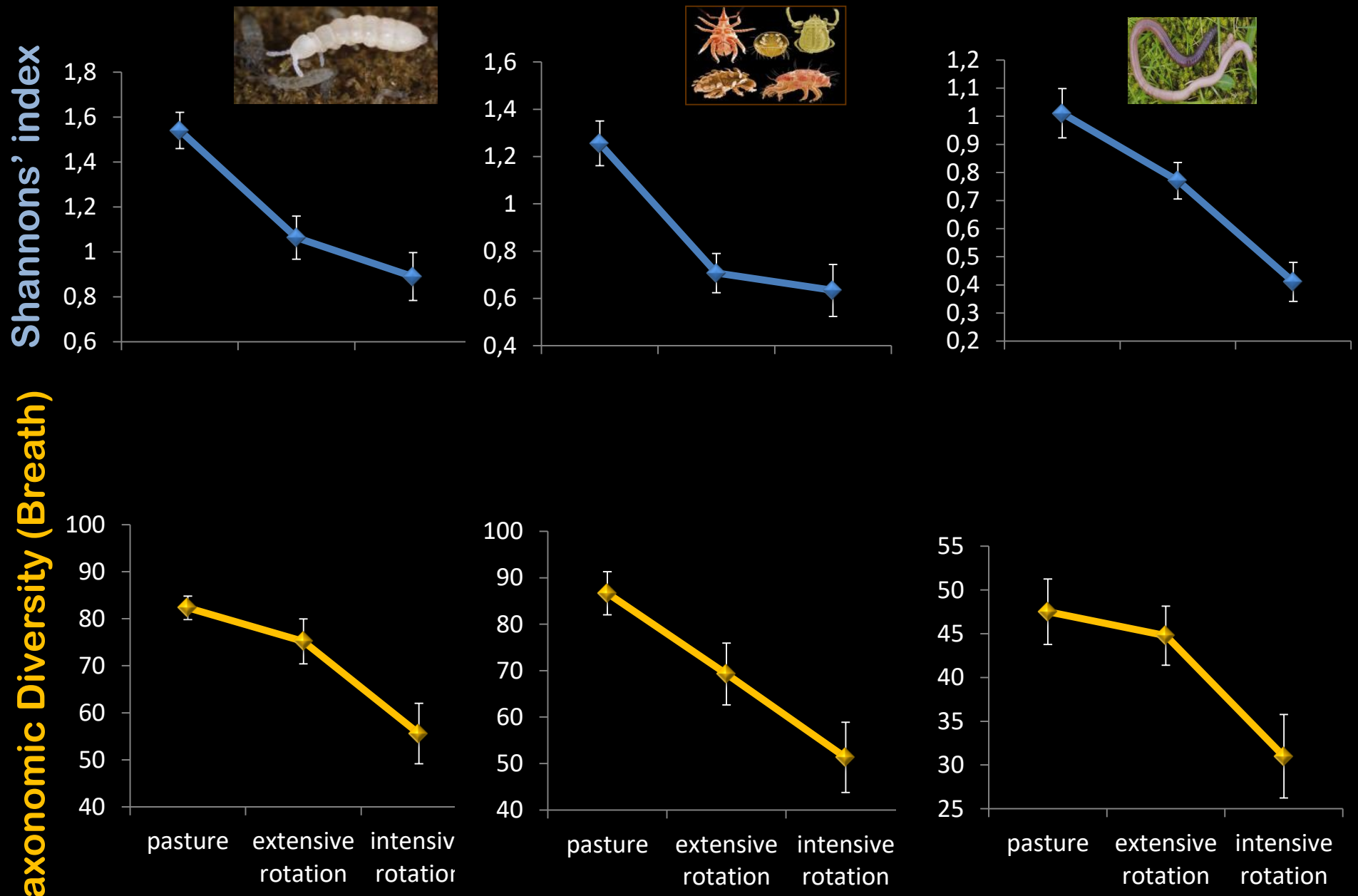
tillage

each year

grazing

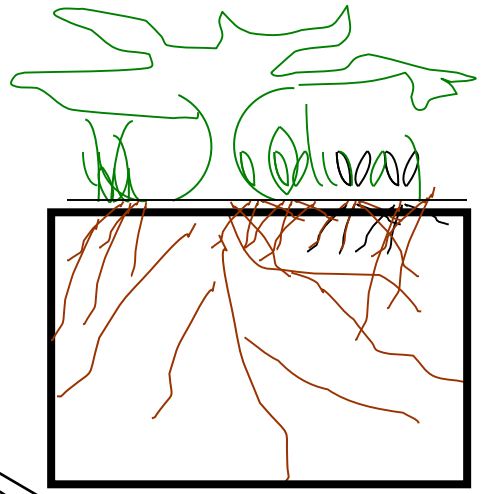
cutting, fertilizing

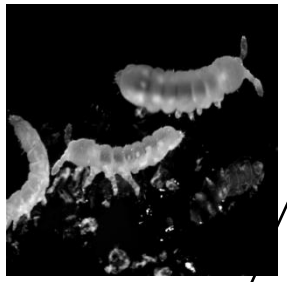
Pasture → Extensive rotation → Intensive rotation

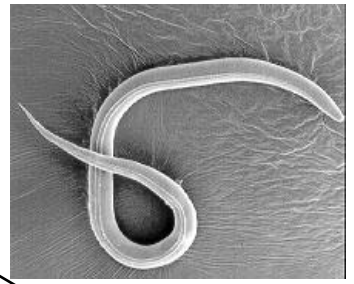



Tsiafouli et al.Global Change Biology 2015

# Soil food web







1 predaceous mites

2 predaceous collembolans

3 nematode feeding mites

4 predaceous nematodes

5 amoebae

6 collembolans

7 cryptostigmatic mites

8 noncryptostigmatic mites

9 fungivorous nematodes

10 bacteriophageous nematodes

11 flagellates

12 bacteriophageous mites

13 phytophagous nematodes

14 saprophytic fungi

15 bacteria

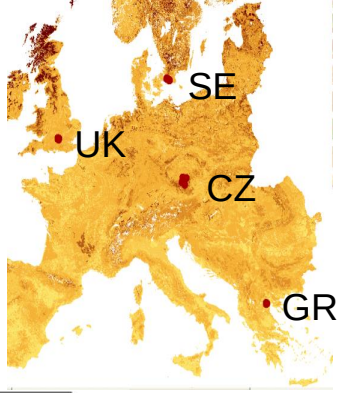
16 roots

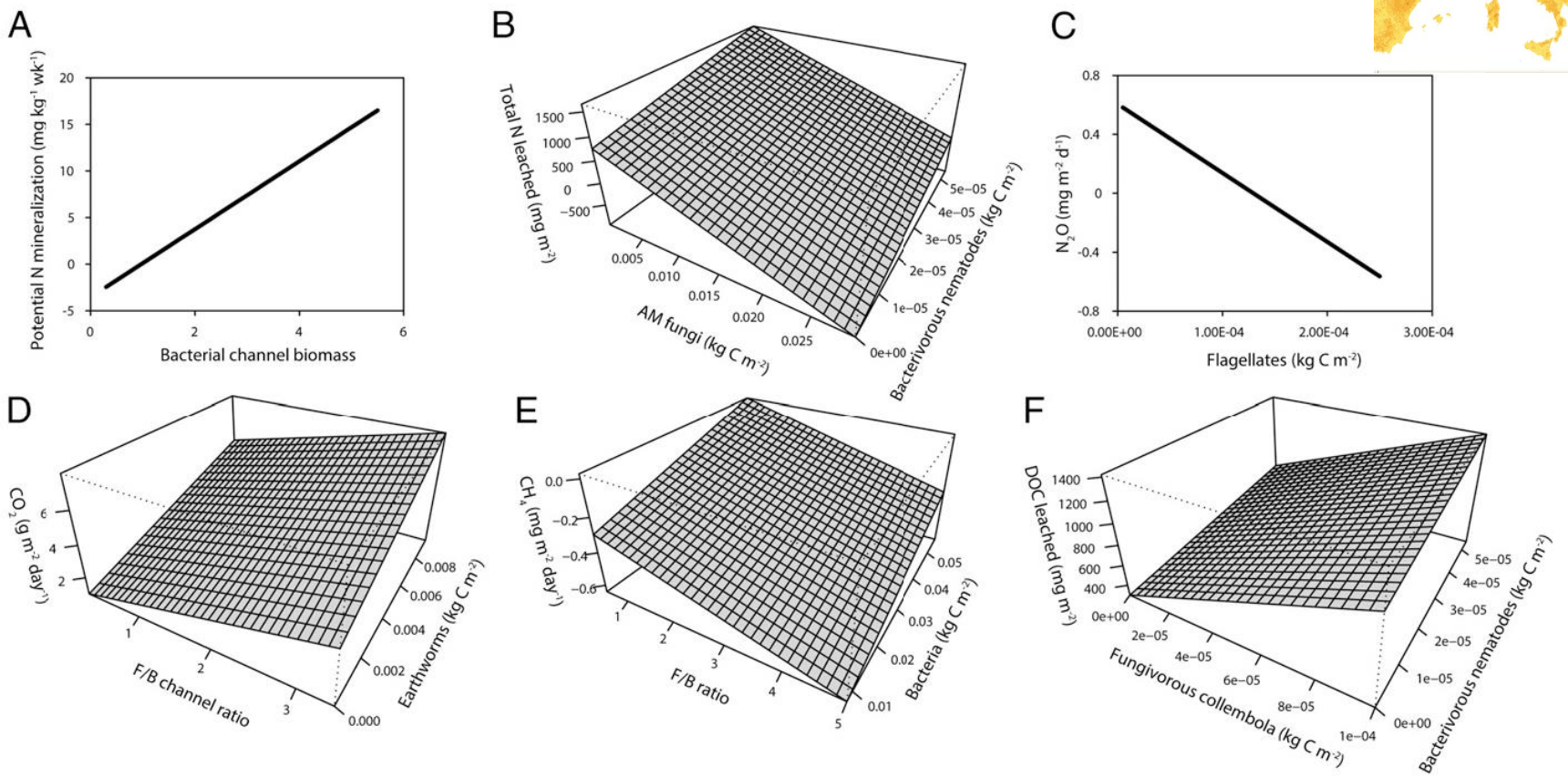
17 detritus

(Semi) natural

Agriculture

# SOILSERVICE

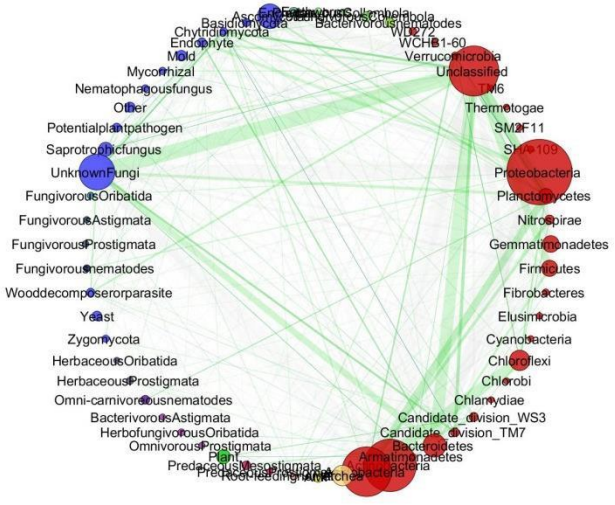


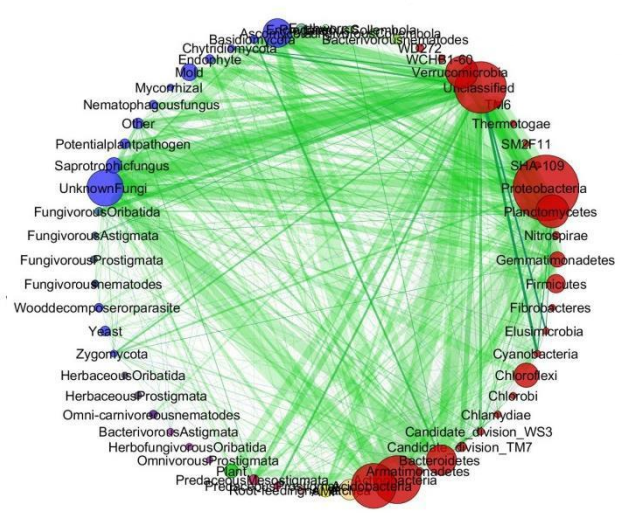

Soil food web analysis: change different ecosystem processes due to land use intensification relate to different soil food web properties: all needed for multifunctionality!

De Vries et al. PNAS 2013

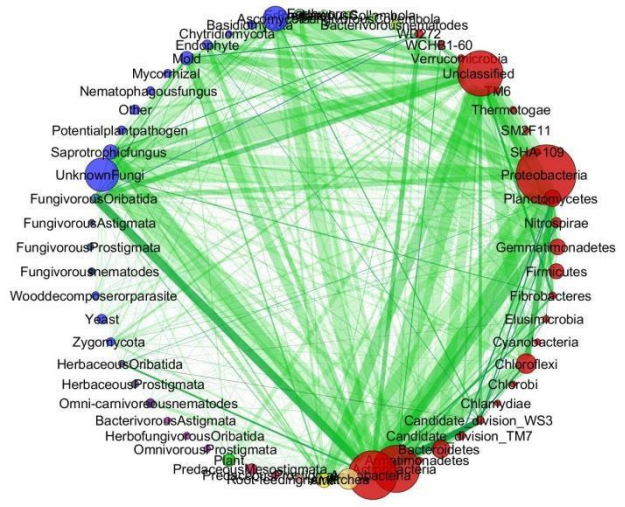
Recent




Mid-term




Long-term




Total > 0.9 interactions


% interactions between two groups > 0.9 of total possible interactions


Soil biodiversity restoration takes a lot of time!
Correlation-based networks in three phases of land abandonment: roughly 5, 15 and 30 years ago

Morriën, Hannula, Snoek, & EcoFinders
Nature Communications (2017)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Why first destroy soil and then restore?

Let’s act now!

Thank you for your attention!