



# Theme 1.

## State of knowledge on soil biodiversity

EMBRAPA  
Brazil

George Brown  
Cintia Niva



# Theme 1 Aims:

- Latest discoveries on taxonomic and genetic diversity of soil organisms
- Benefits from soil biodiversity
- Status of the world's soil biodiversity

=> To strengthen dialogue between scientific community, policymakers and the general public.



# International Initiative for the Conservation and Sustainable Use of Soil Biodiversity (cross-cutting CBD, COP6 - 2002)



Convention on  
Biological Diversity

Review of initiative  
(SBSTTA, May 2020)

World Soil Resources

101



UN  
environment  
programme

CBD

## BIOLOGICAL MANAGEMENT OF SOIL ECOSYSTEMS FOR SUSTAINABLE AGRICULTURE

Report of the International Technical Workshop

Organized by  
EMBRAPA-Soybean and FAO

Londrina, Brazil, 24 to 27 June 2002



Convention on  
Biological Diversity

Distr.  
GENERAL

CBD/SBSTTA/24/7  
8 May 2020

ORIGINAL: ENGLISH

SUBSIDIARY BODY ON SCIENTIFIC,  
TECHNICAL AND TECHNOLOGICAL ADVICE  
Twenty-fourth meeting  
Montreal, Canada, 17-22 August 2020  
Item 7 of the provisional agenda<sup>1</sup>

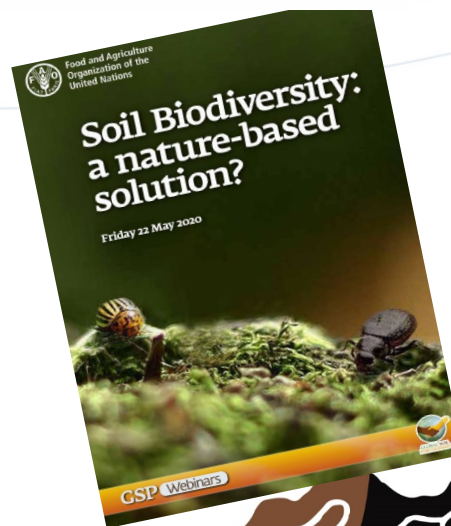
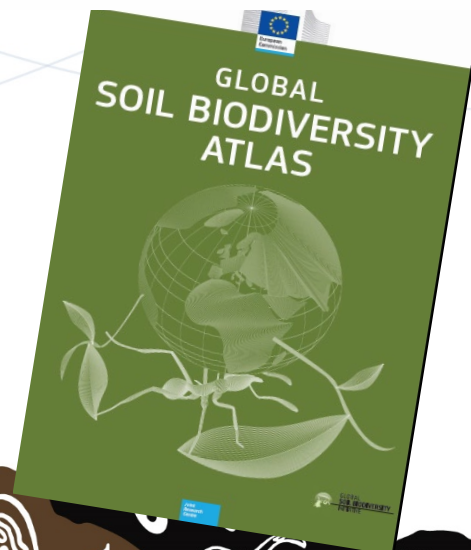
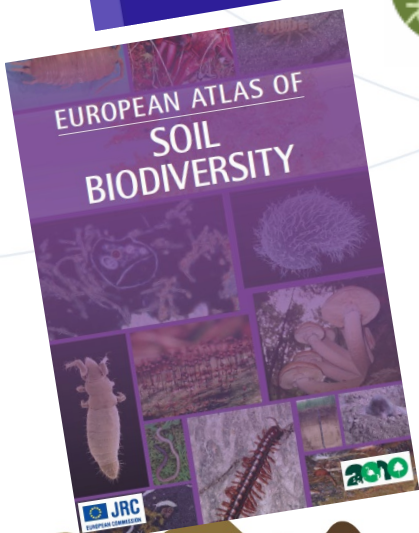
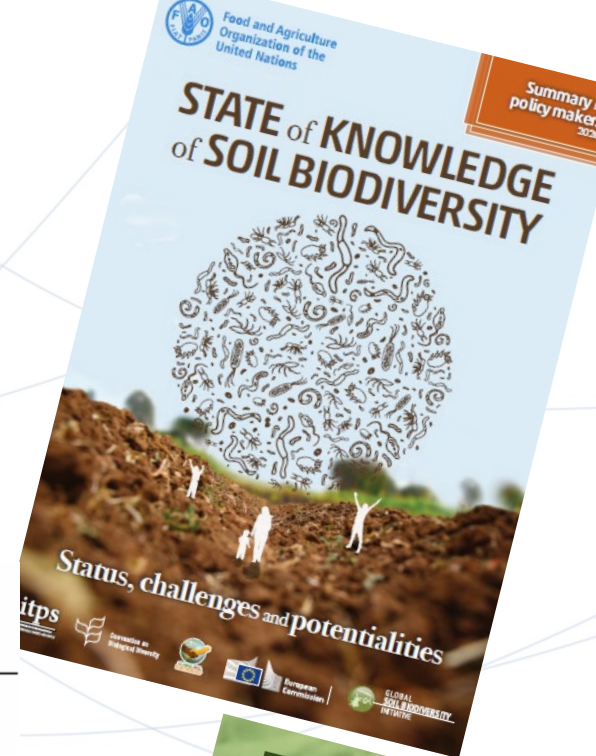
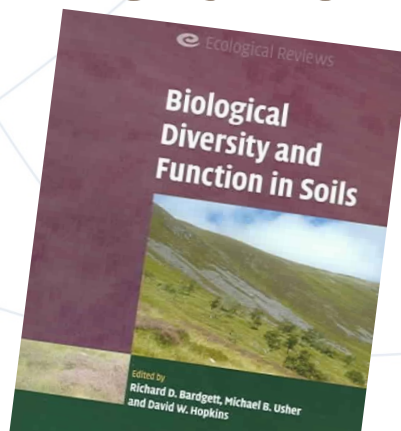
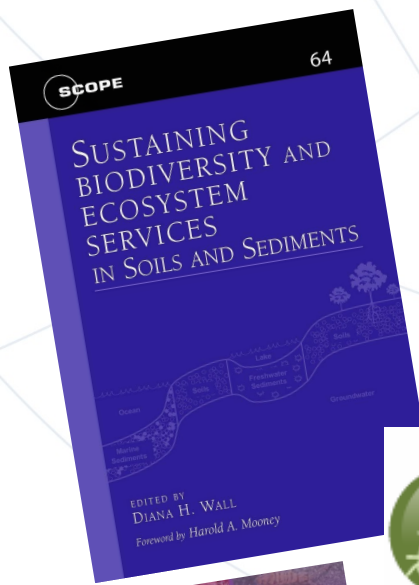
Framework approved  
COP8 (Brazil, 2006)

Framework for Soil Biodiversity Initiative



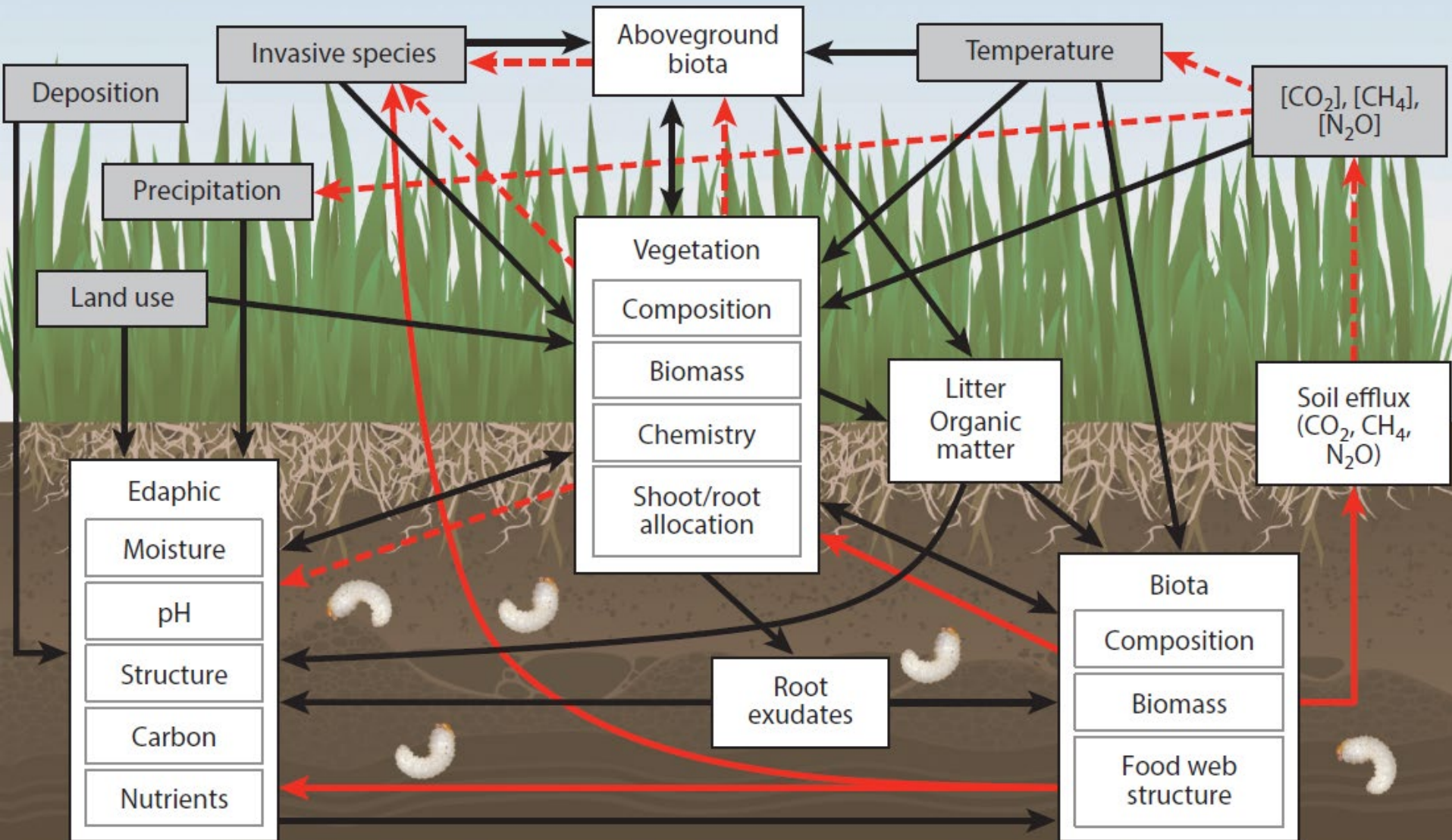


# We've come a long way!



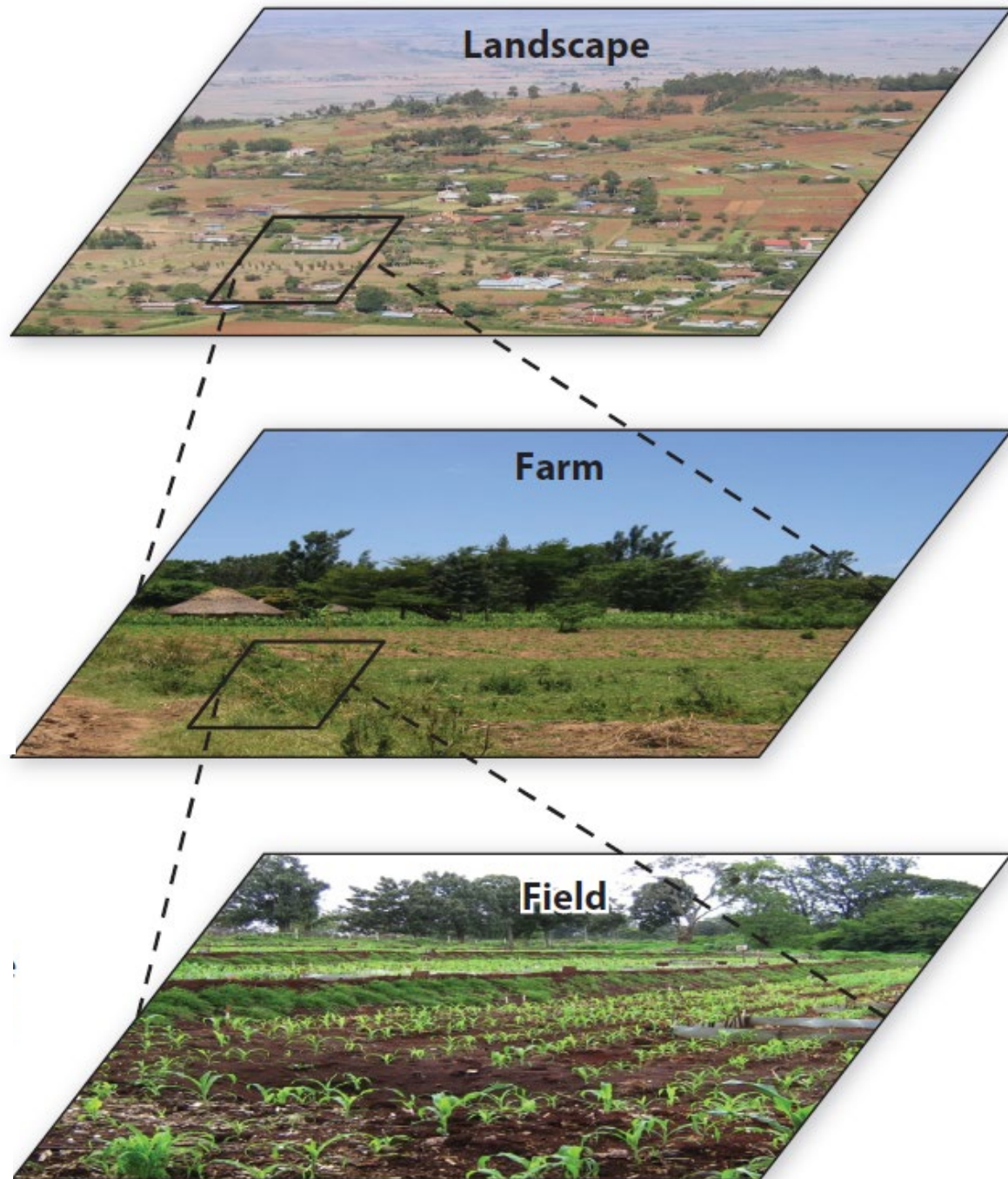
Many variables & interactions to study at different spatial & temporal scales

Nielsen et al. (2015), Ann. Rev. Environ. Resour.





- Regional species pool
  - Provision of ES
  - Adaptability, resistance and resilience to change
- 
- Local populations of soil biota
  - Species diversity & activity in relation to LU practices & management
- 
- Nutrient cycling, uptake
  - Plant growth
  - Pest suppression
  - SOM regulation
  - Soil structure & water



# Important scientific progress:

- Molecular tools to describe unknown biodiversity
  - Metagenomics, microbiomes, e-DNA
  - Transcriptomics (functional aspects)
- Greater computing power, machine learning, remote sensing tools, statistical tools
- Wider adoption of proxies of diversity
- Assessment of ecosystem functions & services
  - N<sub>2</sub> fixation (Billions of US \$ in fertilizer savings)
- Country syntheses; global for some taxa
- National & global initiatives, assessment, monitoring



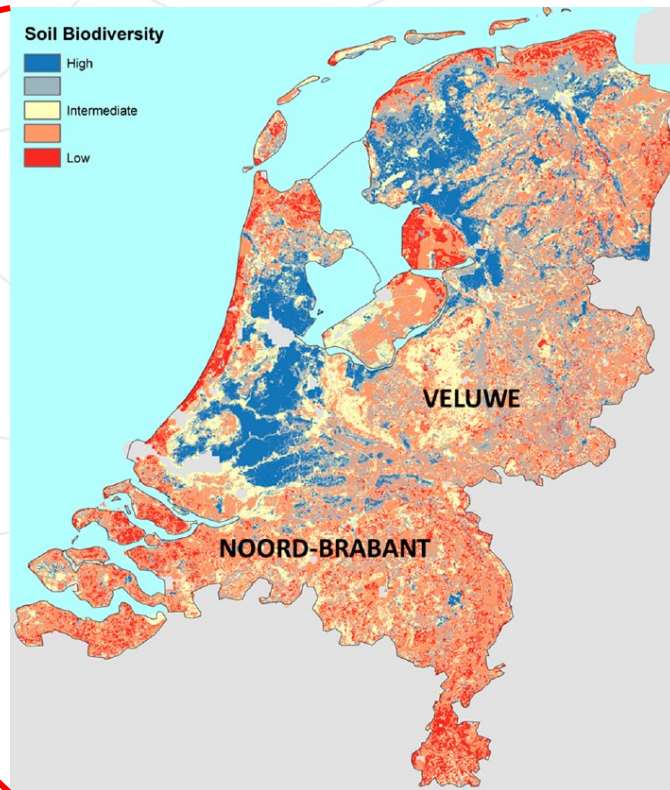


## Soil Biodiversity



6 biological attributes, 5 proxies  
for function (soil chemistry)

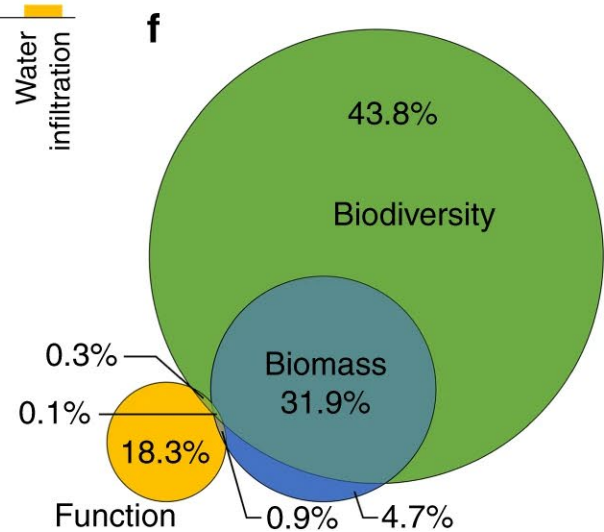
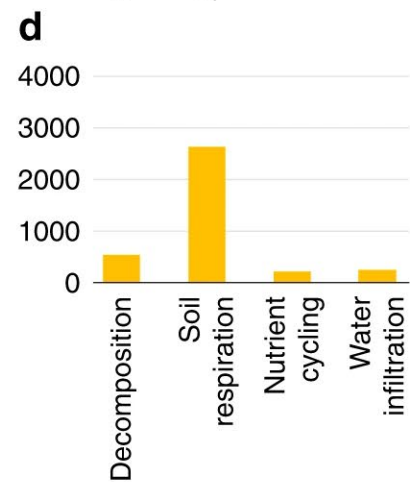
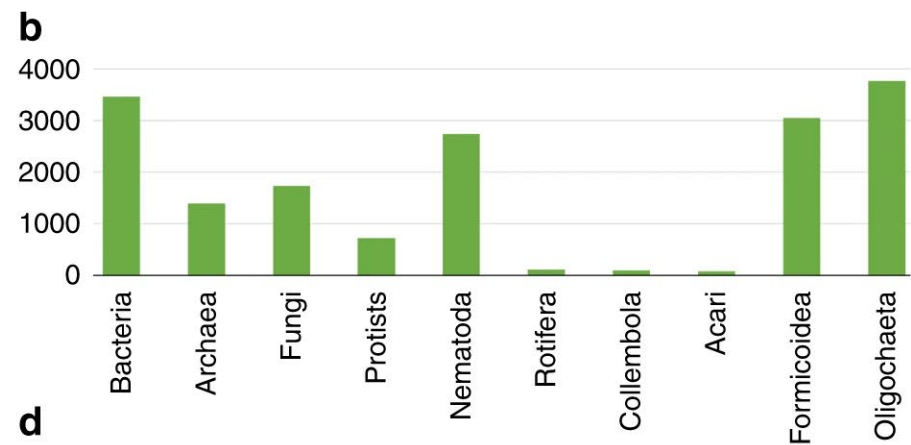
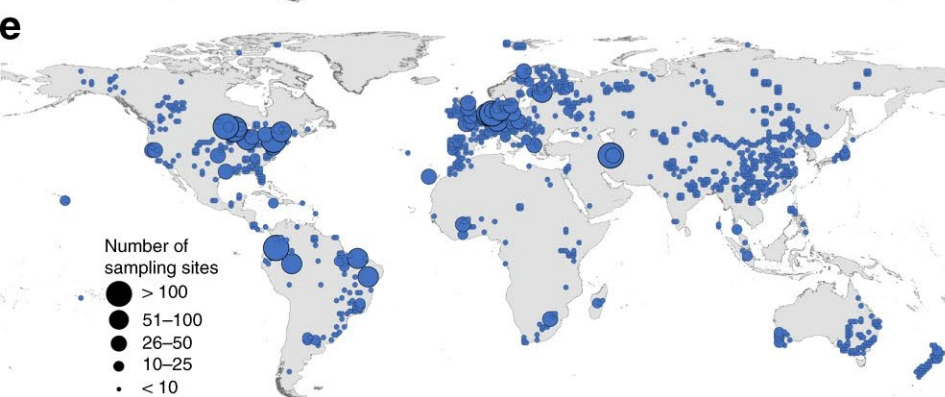
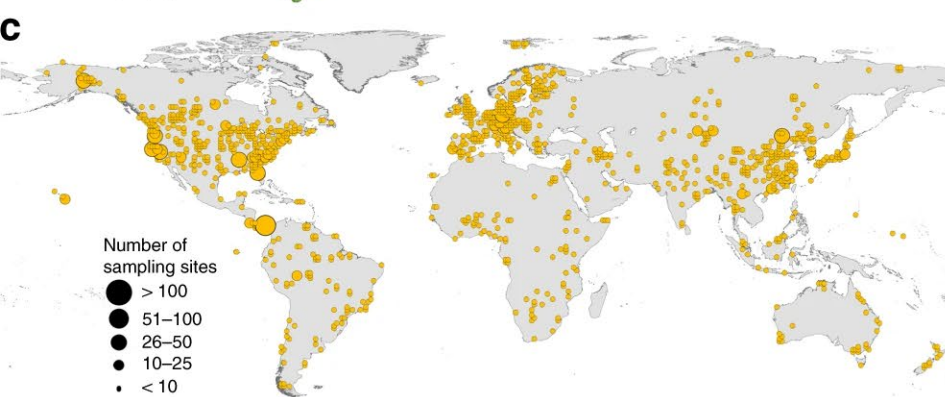
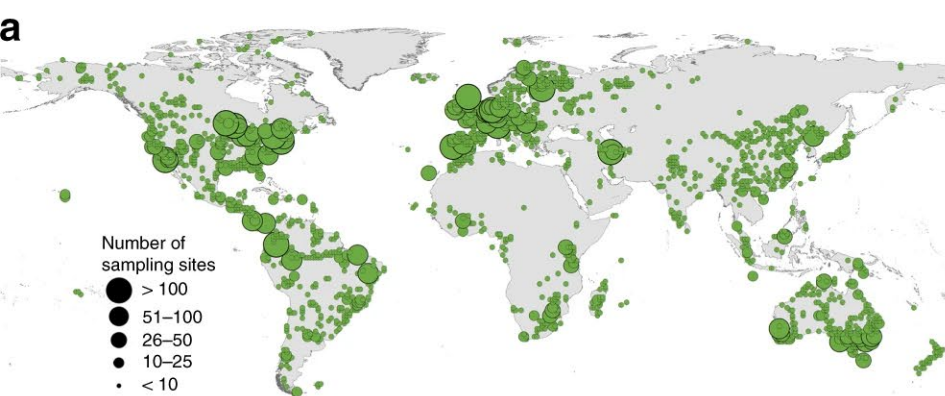
The Netherlands soil quality  
monitoring network (11 soil  
biological attributes)



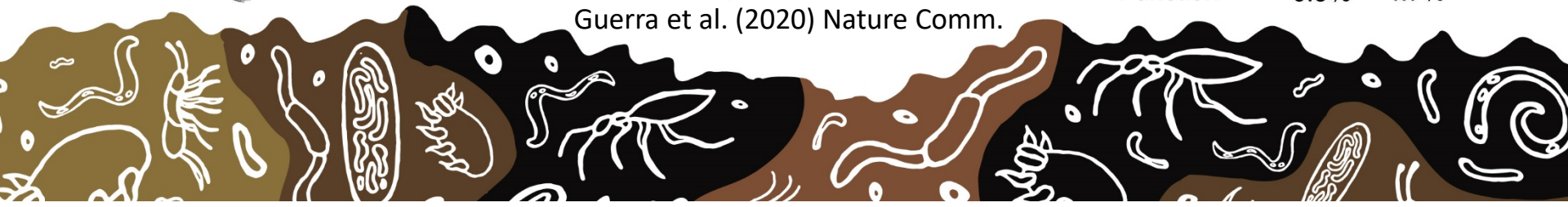
Rutgers et al. (2019), Soil Syst.







Guerra et al. (2020) Nature Comm.



# But still a lot to do!

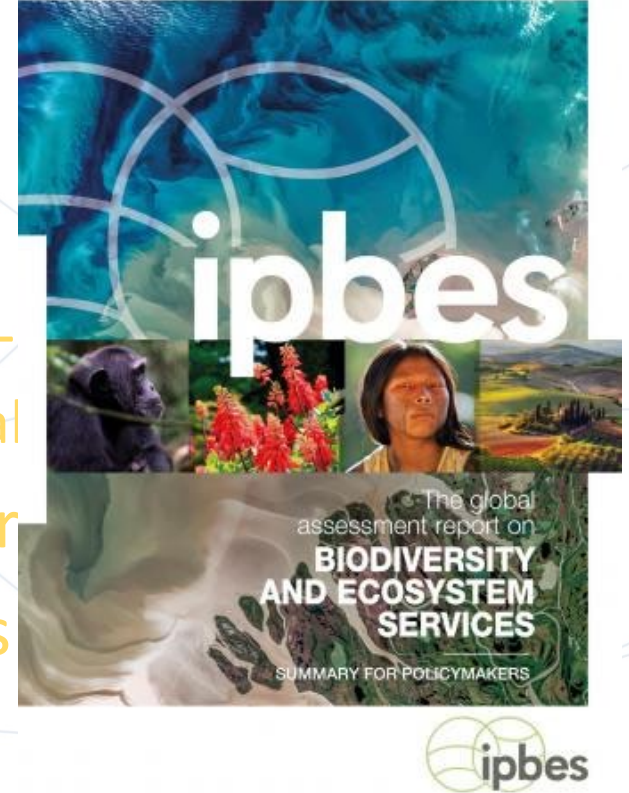
- Most biota remain unknown and un-named
  - no IUCN conservation status even if potentially endangered!
- Many gaps in knowledge, both geographic and biological
- Taxonomists are endangered species
- Few monitoring programs
- Few quantitative & economic valuation of ES
  - IPBES Report practically ignored soil biodiversity
- Need for integrative, collaborative, standardized, comparable studies and results worldwide => Networks!

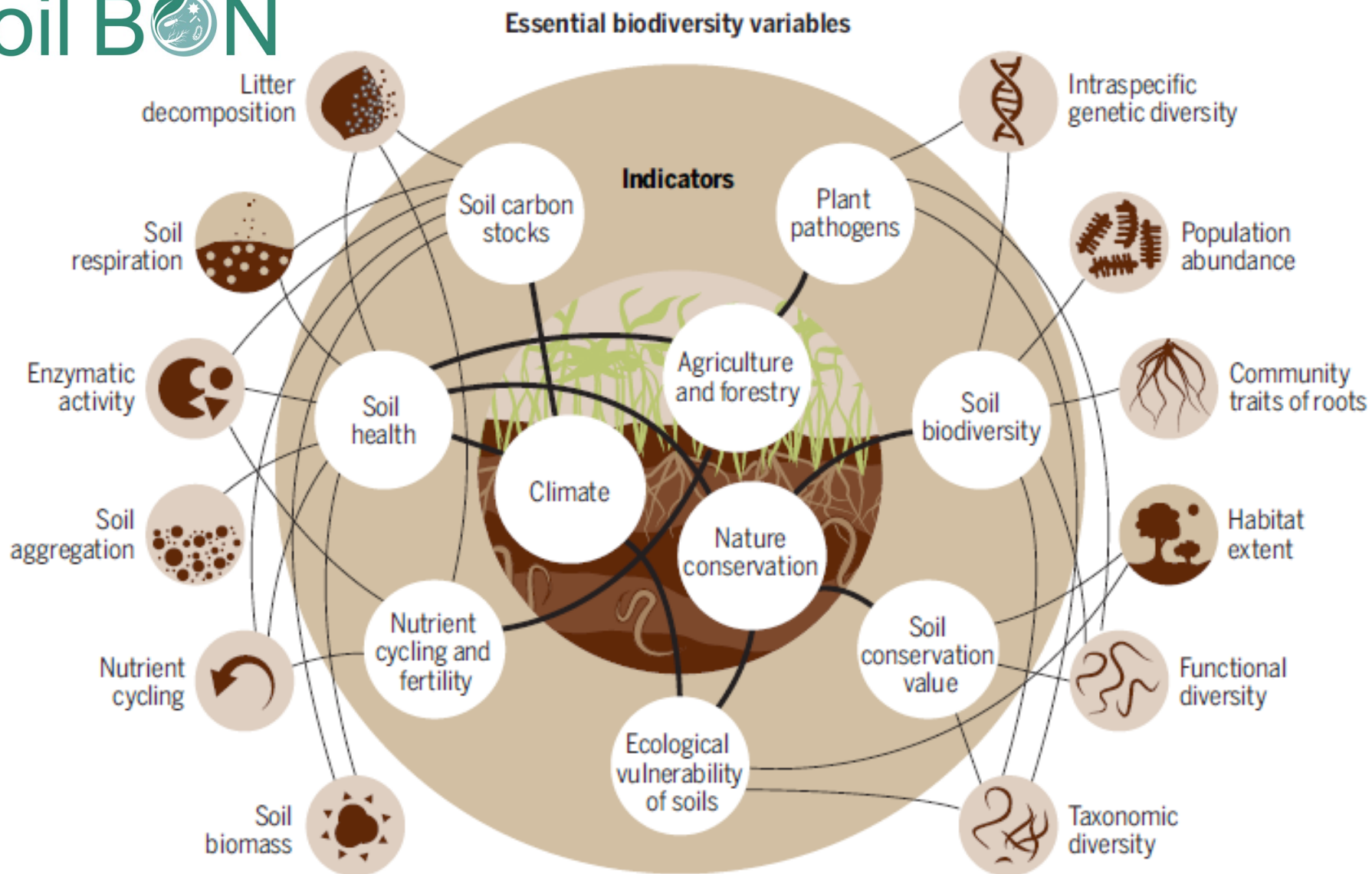




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Guerra et al. (2021), Science



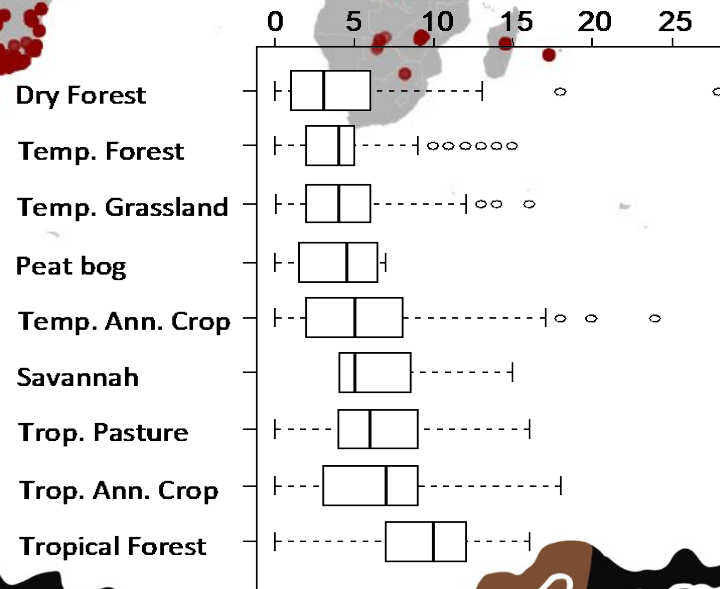


# Soil macrofauna Network (TSBF)

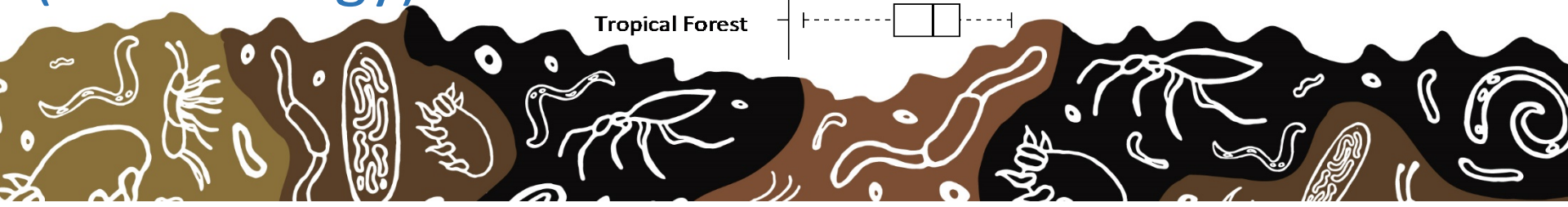
Mathieu et al. (unpublished)

8700 sites

Mycorrhizal  
Network  
ALAR  
(rhizobiology)



Lavelle et al. (under review), 3700 sites



KEEP SOIL ALIVE  
PROTECT SOIL  
BIODIVERSITY

# GLOBAL SYMPOSIUM ON SOIL BIODIVERSITY

19-20-21-22 April 2021



>120 oral presentations

50 posters

**Some highlights**





# 1. Biodiversity discoveries, distribution patterns

Ants and termites in  
Colombian Amazon  
Castro et al.



Ground-nesting  
bees

Christmann

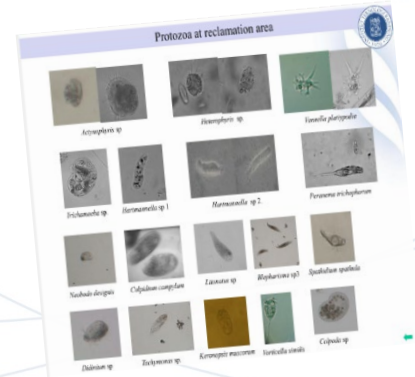


Flying soil biota

Prokaryotic  
metacommunity in  
Western Amazonia  
Rocha et al.



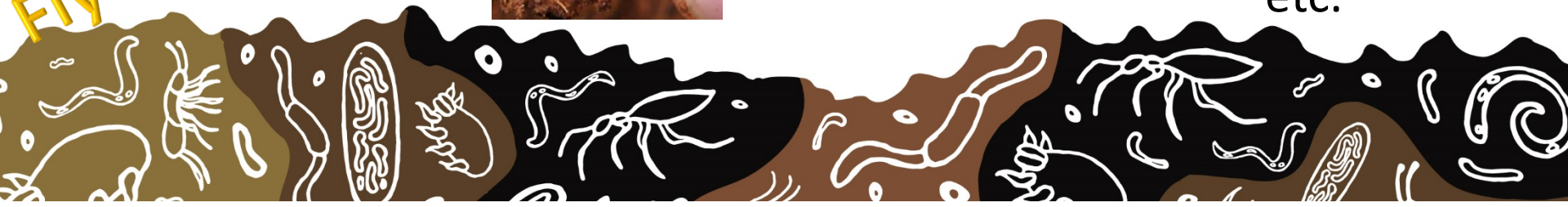
Protozoa in  
Indonesia, Italy  
Syamsudin et al.  
La Terza et al.



New  
enchytraeids  
in Cerrado  
Niva et al.



Soil biota of Georgia,  
Mexico, Colombia,  
Iran, S. Tyrol, Puna,  
Valencia, Vitosha,  
etc.



## 2. Technological advances & measurements

### Traditional & indigenous knowledge

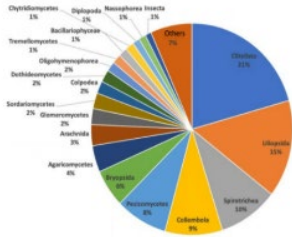
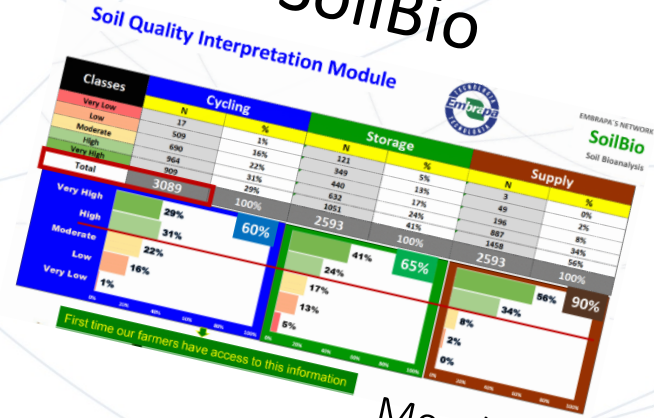


Figure 2: Global composition of eukaryotes in soil samples.

### e-DNA & Metabarcoding

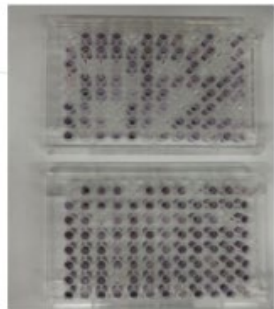
Bellemain et al., Gonzales et al., Borruco et al.

SoilBio

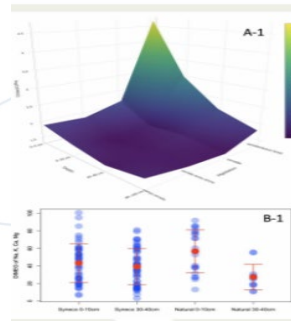


Mendes et al.

### Ecoplates (metabolic fingerprinting)



Gonzalez et al.



### Chemical kinetics of soil ions

Funabashi

### Terra Preta Nova

Ferreira et al.

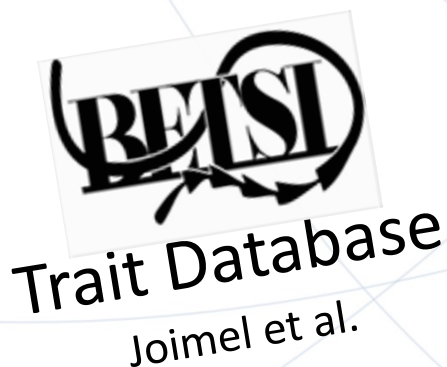




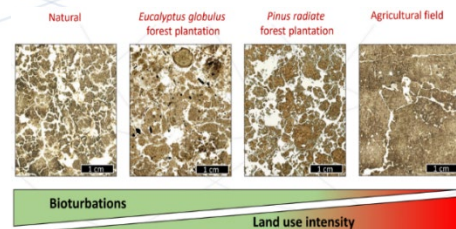
# 3. Measuring ecosystem functions/service delivery



Brauman et al. (2018)

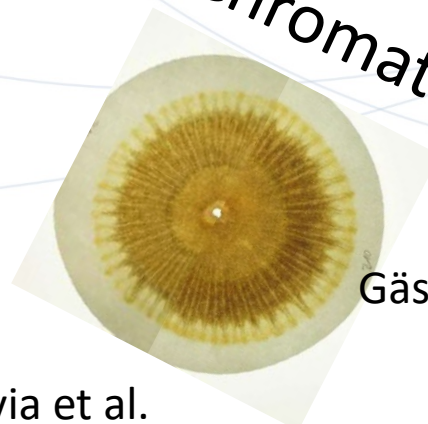


Bioturbation  
(Morphology, tomography)



Alvarez et al.

Soil Chromatography



Gässler et al.

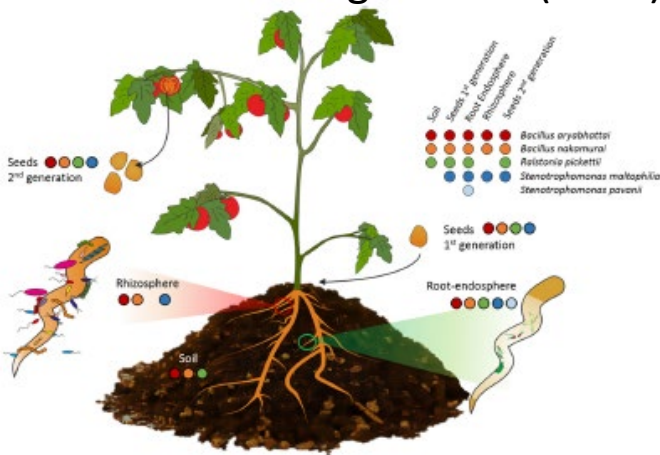
Chouyia et al.



Mowery et al.



Bergna et al. (2018)



# Further examples of tools & indicators used

QBS-ar – Soil Biological Quality  
using microarthropods  
studies in Italy, UK, Bolivia...

| QBS-ar<br>Index Value | Judgement   | Quality Class |
|-----------------------|-------------|---------------|
| >120                  | Excellent   | I             |
| 101-120               | Good        | II            |
| 81-100                | Fairly Good | III           |
| 61-80                 | Sufficient  | IV            |
| 41-60                 | Modest      | V             |
| 31-40                 | Poor        | VI            |
| <30                   | Null        | VII           |



Macroinvertebrates, earthworms,  
microbial diversity as indicators of  
impact of pesticide use, LU changes  
e.g., Huerta-Lwanga et al.; Sasmita et al.; Vischi  
Filho et al...



Bioturbation, soil hydrology,  
structure

Hallam et al.



Scoring functions by integrating  
microbial and soil properties  
Aranguren et al.





# 4. Mapping, monitoring and reporting

## Citizen Science (underpants)

Bender et al.

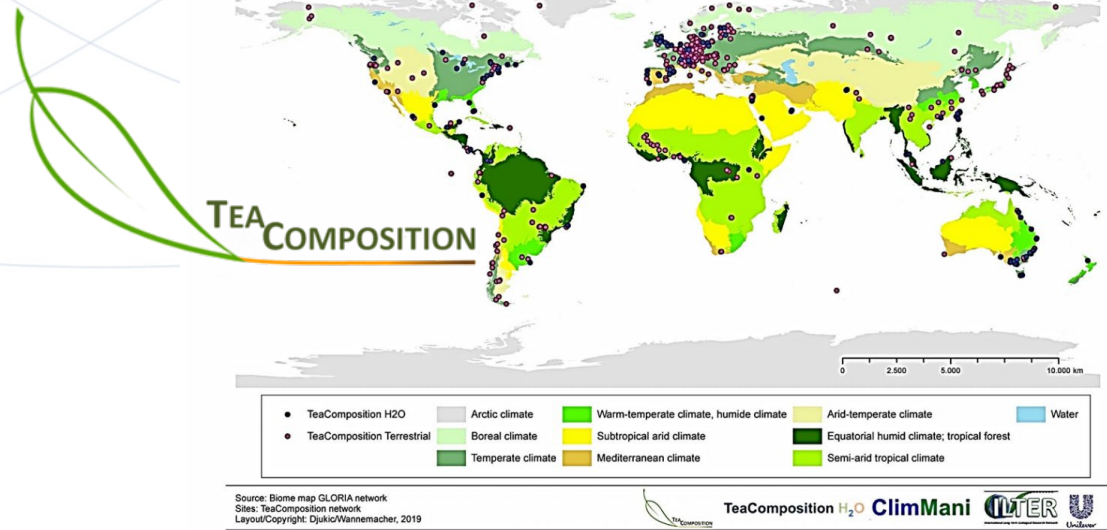


[www.beweisstueck-unterhose.ch](http://www.beweisstueck-unterhose.ch)

## Soil Health Assessment Initiative (USA)

Knaebel

## National & Regional Soil Biodiversity Monitoring Networks: *France, Italy, Germany*



Djukic et al.

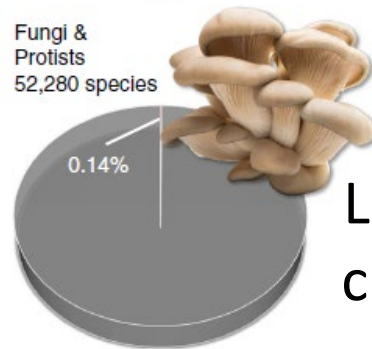
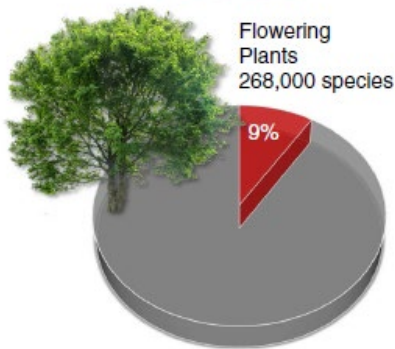
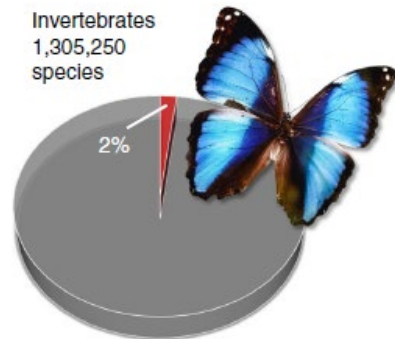
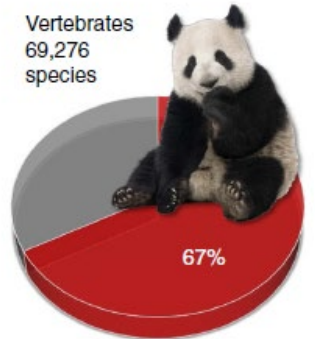


# 5. Status & trends of soil biodiversity at different spatial/temporal scales

Getting soil biota into redlists:  
Invertebrates under-represented  
Microbes practically absent

Conservation, organic  
& urban agriculture  
Joimel et al.

Land-use and climate  
change, ES delivery &  
biodiversity  
Rocha et al.



Eisenhauer et al. (2019), Nat. Comm.







Vinisa Saynes Santillan  
Rosa Corona Cuevas

# Thank you for your attention!

