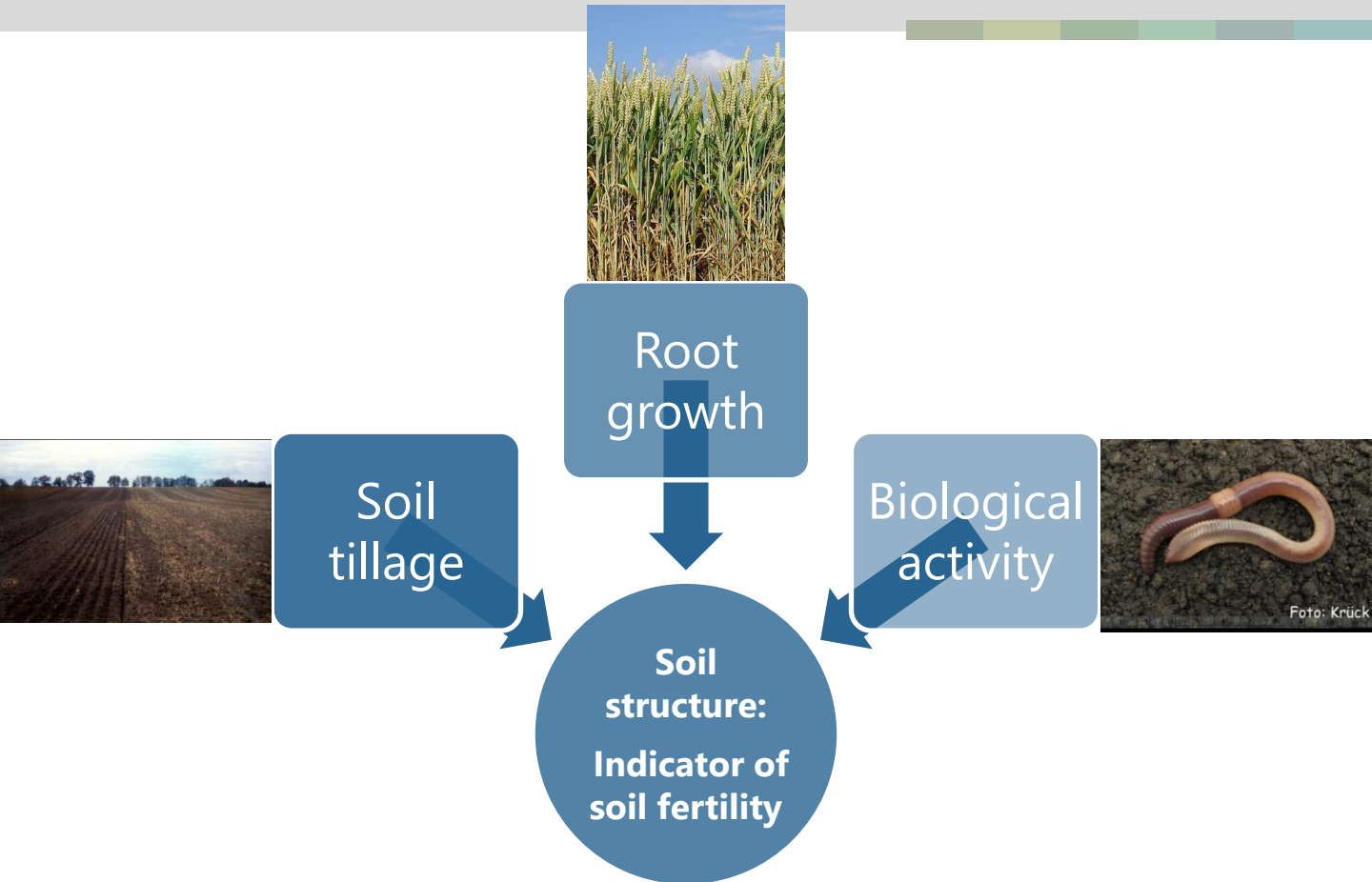


X-ray CT assessment of soil structure: a tool for monitoring soil biota driven ecosystem services in agricultural soils

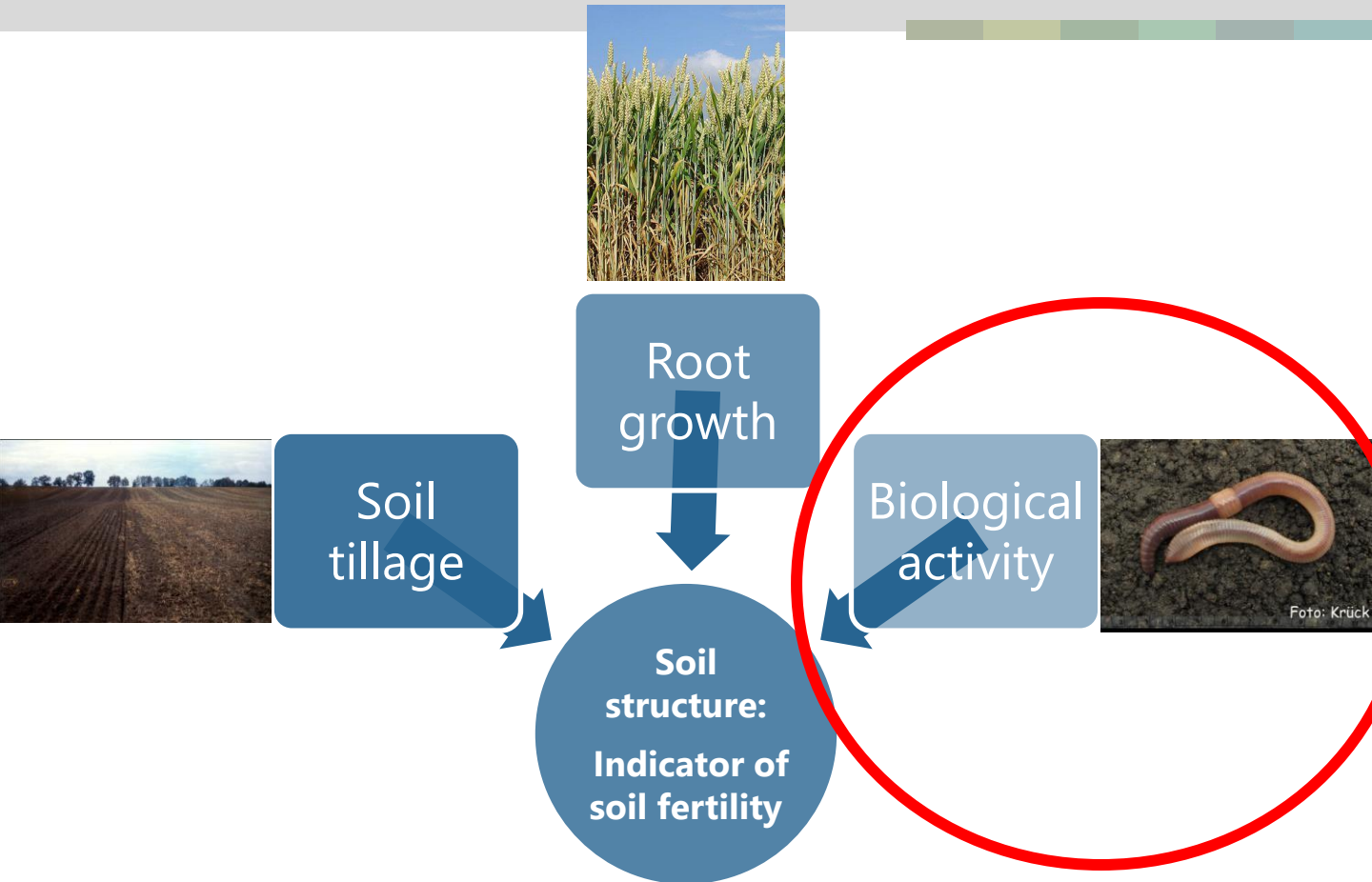
Monika Joschko, Dietmar Barkusky, Ralf Wieland, Adrian Krolczyk, Matthias Willms, Wilfried Hierold (ZALF), Guido Fritsch, Thomas B. Hildebrandt (IZW), Lucian Elles (TU Berlin), Lei Li, Olaf Schmidt (UCD Dublin), Juliane Filser (Universität Bremen), Juan Jimenez (IPE-CSIC Jaca), Jack Faber (Alterra Wageningen), Jana Epperlein (GKB), Michael Schirrmann (ATB), Catherine A. Fox (AAFC), Marcel Budras, Felix Gerlach (Komturei Lietzen), Anita Beblek (agrathaer)



Rationale



Rationale



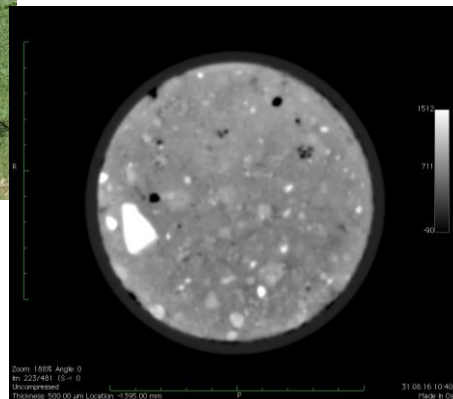
What is known ?



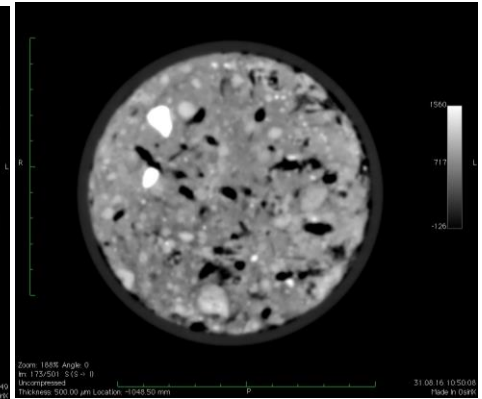
Sampling undisturbed soil cores



Soil structure (medical X-ray
computed tomography, 12 cm
diameter topsoil samples) (IZW
Berlin) indicates earthworm
abundance and activity

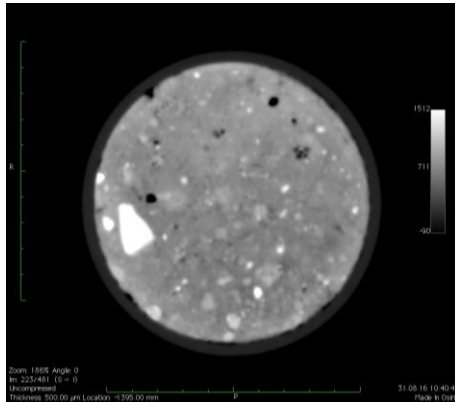


8 earthworms/ m²
Conventional tillage

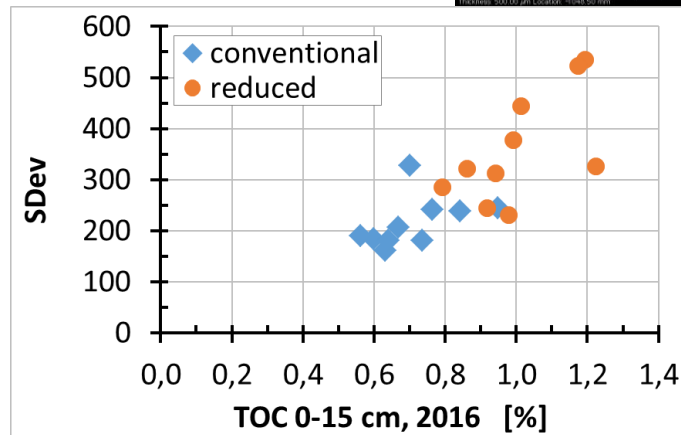
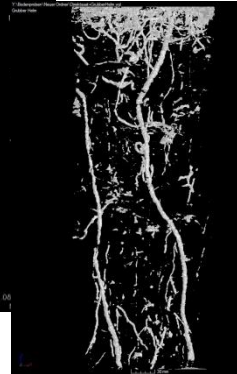
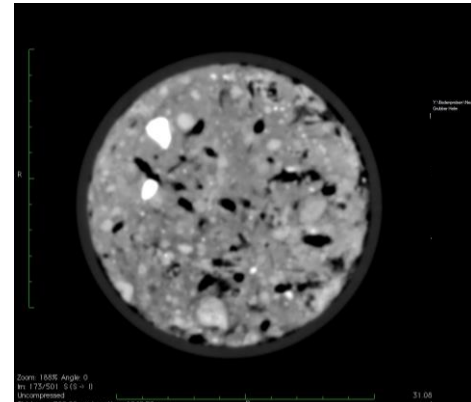


276 earthworms / m²
Reduced tillage

CT assessed soil structure indicates soil biota induced ESS



ESS:
Structure
formation



ESS:
Carbon
sequestration

How to incorporate this knowledge about biodiversity and ESS into the agricultural practice ?

Smart
Simplification !

COST Action ES 1406 KEYSOM



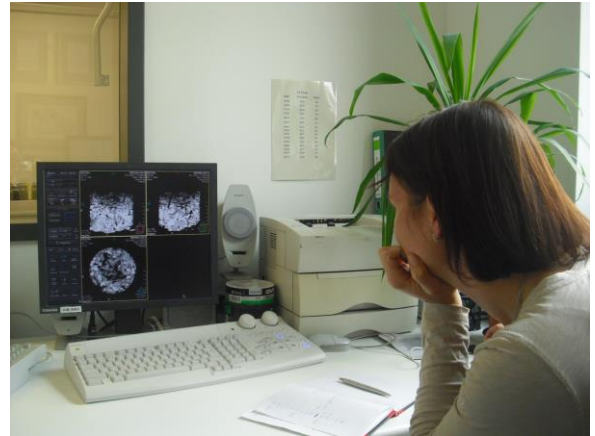
36 top soil
samples from 16
countries

grassland
and forest

Smart simplification 1: Sampling and shipment of undisturbed soil samples



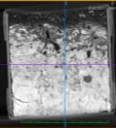
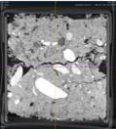
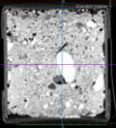
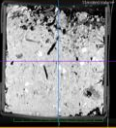
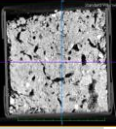
Medical X-ray computed tomography



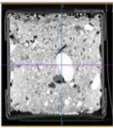
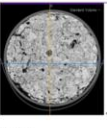

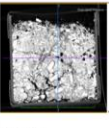

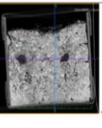
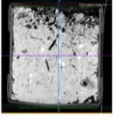
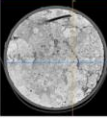
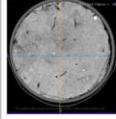

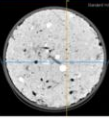
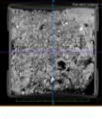
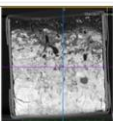
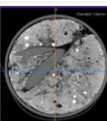
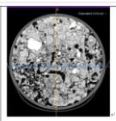
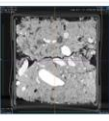
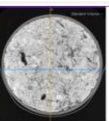
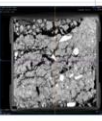
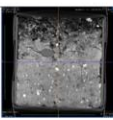
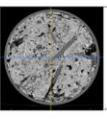
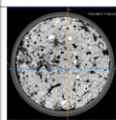
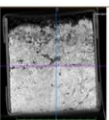
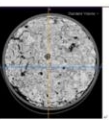
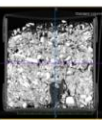
resolution: 0.3 mm

IZW Berlin

Morphometrics of selected soil cores (Elles, TU Berlin)


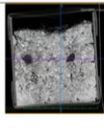
	# Pores 2 mm	Vol mm ³	Surf. mm ²	Euler #	# Pores 5 mm	Vol mm ³	Surf. mm ²	Euler #	Med. CT
Cost 10 Cro	109	3924	7126	95	62	3780	6567	48.5	
Cost 15 UK	152	14137	22609	-32	94	13949	21860	-89.5	
Cost 16 UK	412	6255	15407	367.5	302	6108	14714	258.5	
Cost 23 Ro	137	4937	9441	103.3	79	4759	8780	52.3	
Cost 24 Ro	178	8347	17512	133.3	102	8098	16550	61.8	

Smart simplification 2: Design of simple categories with 4 levels

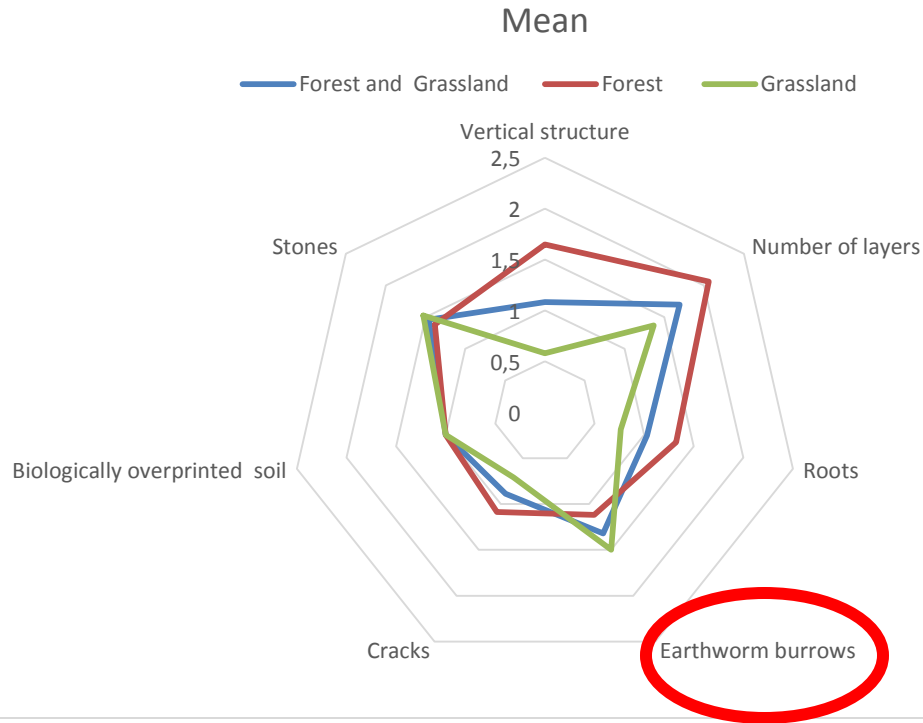
Categories	Vertical structure	Root	Earthworms burrows	Cracks	Biologically reworked soil	Stones
Range	0-3	0-3	1-3	0-3	1-3	0-3
Example 1 The level of value 0	 Cost 16	 Cost 9	 Cost 14	 Cost 8	 Cost 23	 Cost 6
Example: The level of value 1	 Cost 23	 Cost 6	 Cost 12	 Cost 3	 Cost 23	 Cost 27
Example: The level of value 2	 Cost 10	 Cost 17	 Cost 7	 Cost 15	 Cost 10	 Cost 26
Example The level of value 3	 Cost 17	 Cost 30	 Cost 24	 Cost 6	 Cost 9	 Cost 13

Smart simplification 2: Simple categories with 4 levels

Earthworm burrows

Categories	Vertical structure	Root	Stones	Biologically reworked soil	Stones
Range	0-3	0-3	1-3	0-3	1-3
Example 1: The level of value 0	 Cost 16	 Cost 9	 Cost 14	 Cost 23	 Cost 8
Example: The level of value 1	 Cost 23	 Cost 6	 Cost 12	 Cost 3	 Cost 27
Example: The level of value 2	 Cost 10	 Cost 17	 Cost 7	 Cost 15	 Cost 10
Example: The level of value 3	 Cost 17	 Cost 30	 Cost 24	 Cost 6	 Cost 13

Simple categories suitable for distinction of system states! (based on COST ES1406)



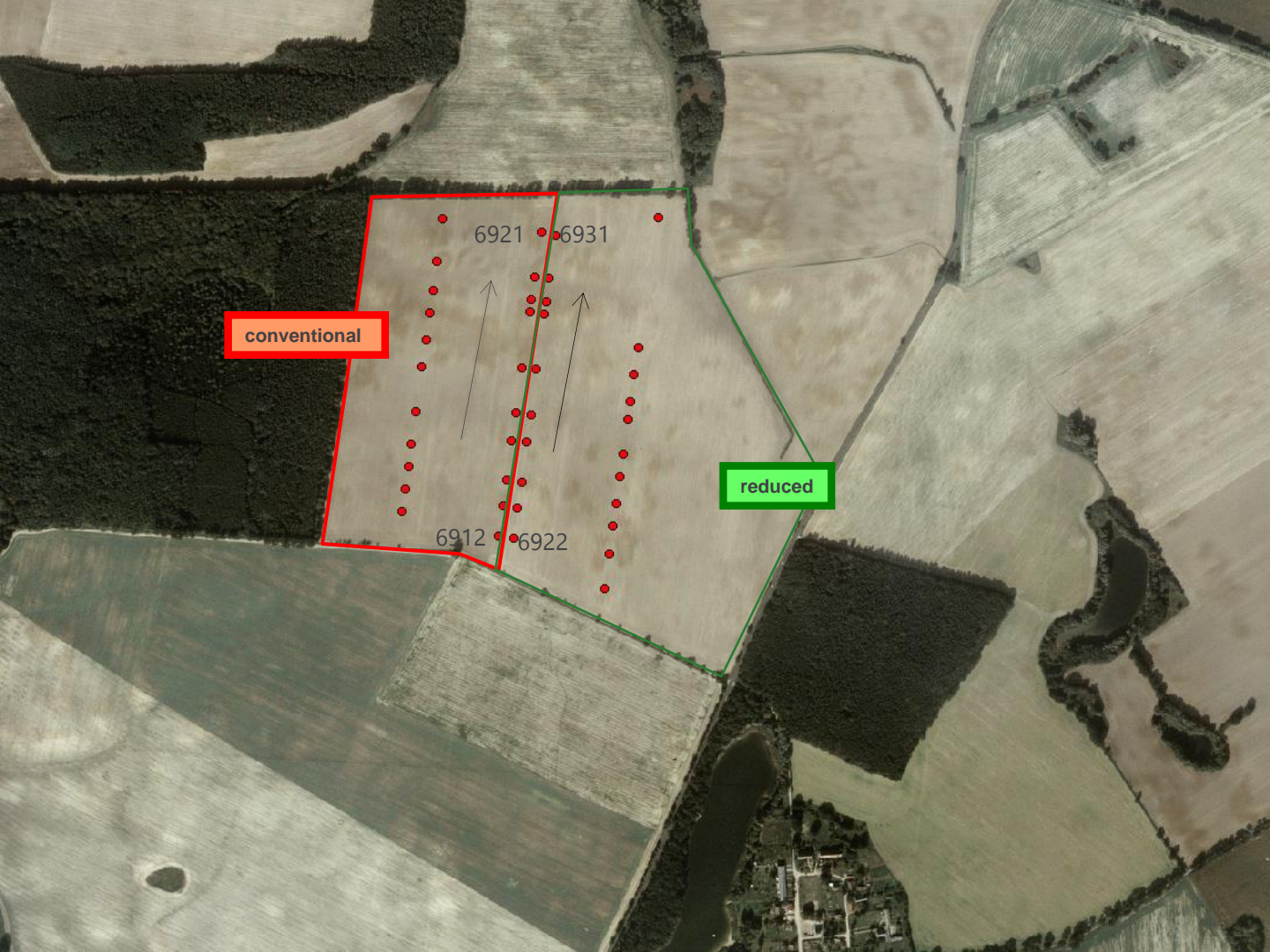
How to incorporate this knowledge about biodiversity and ESS into the agricultural practice ?

Proof of concept:
Long-term tillage experiment Lietzen
(since 1996)



conventional

reduced



conventional

reduced

6921

6931

6912

6922

Example: Long-term Field Experiment Lietzen

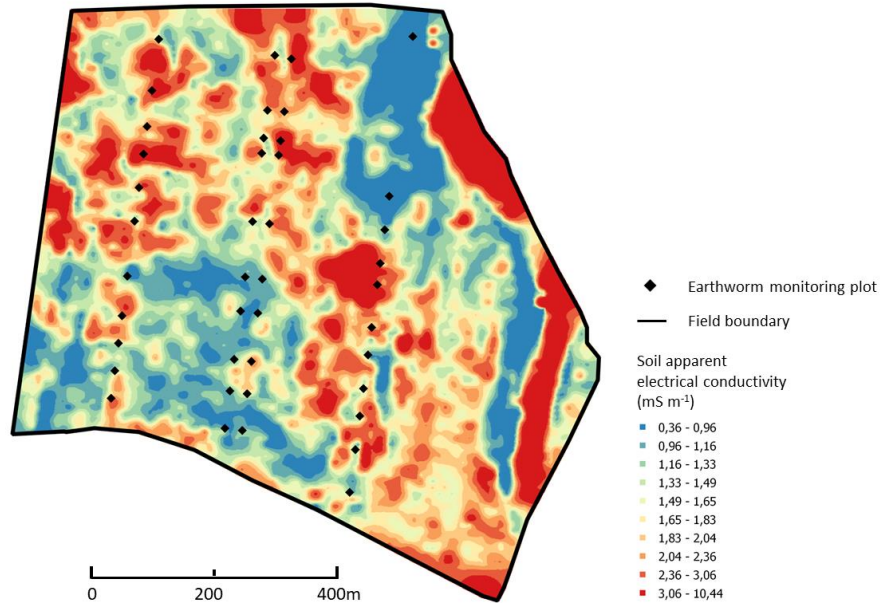


Abundances, assessed by hand sorting, strongly related to soil properties (fine particles)

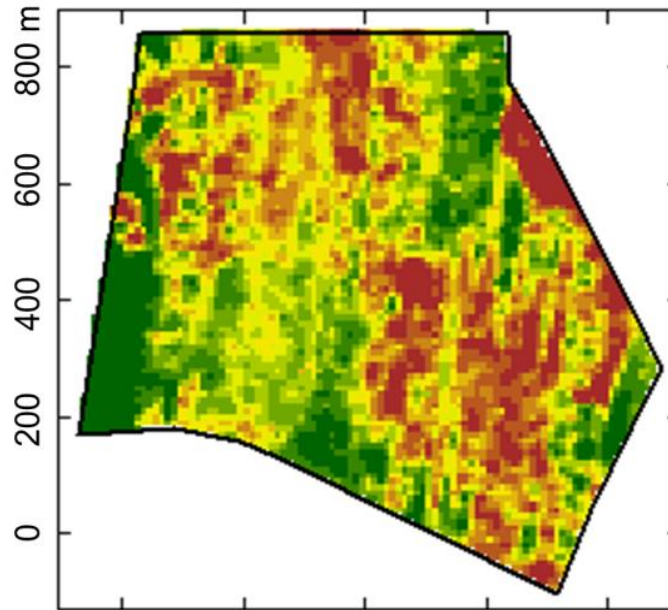


Proximal soil sensing for Eca, pH, Corg (ATB)

Soil map based on proximal soil sensing



Earthworm distribution map based on long-term study of earthworm abundances at 42 plots and proximal soil sensing

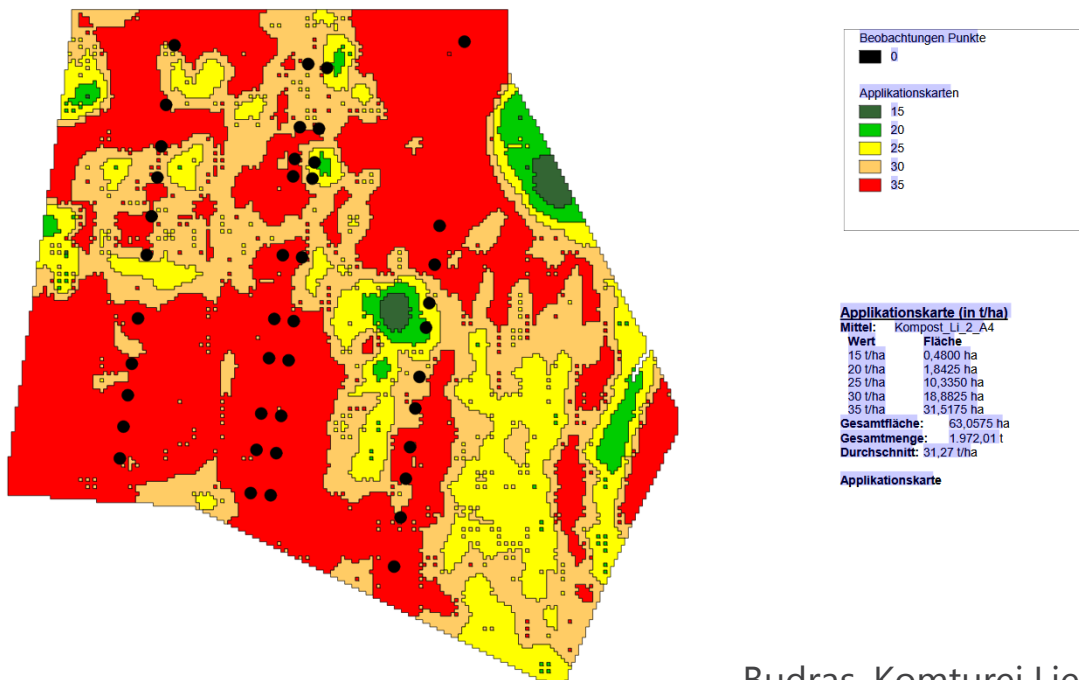


All species model:

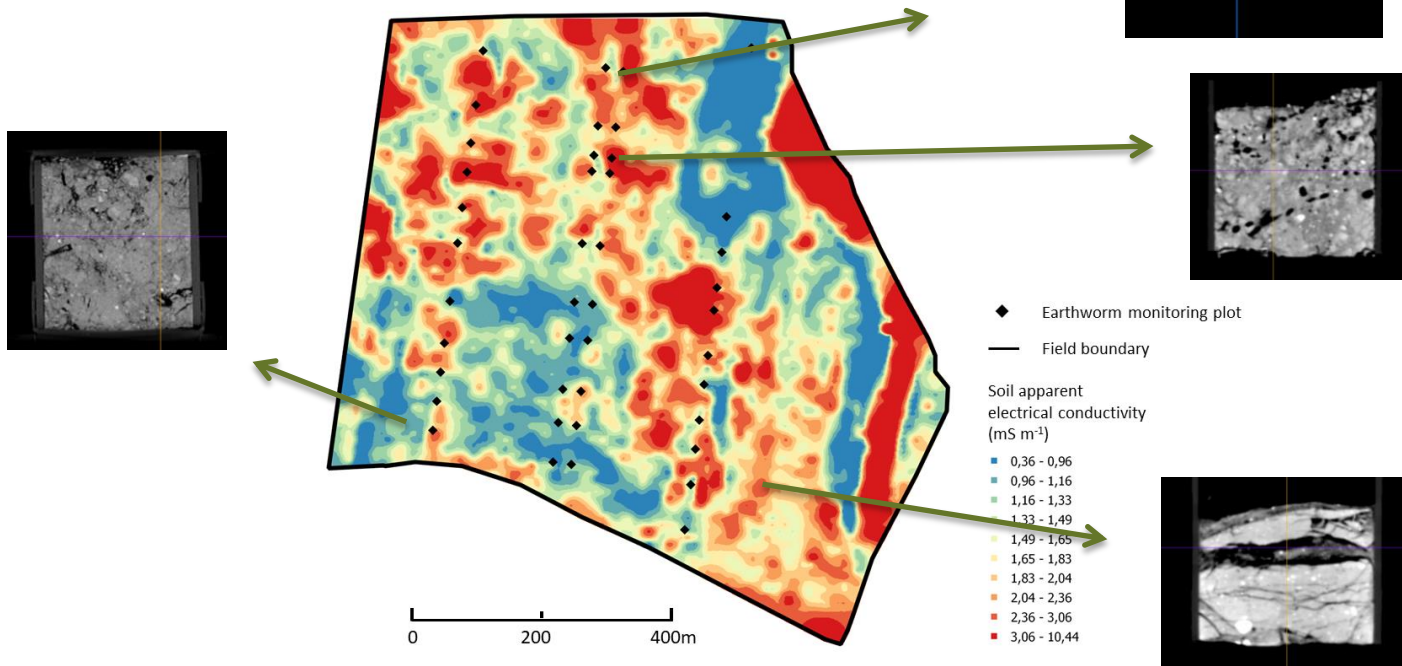


Usage of earthworm abundances for the delineation of management zones !

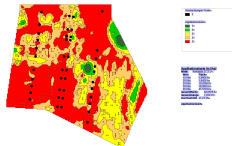
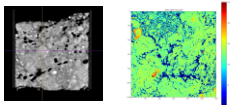
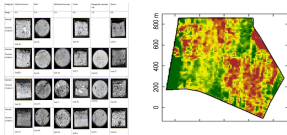
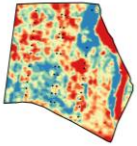
Application map for site-specific fertilization with organic manure



Next step 2020: CT assessed soil structure for the delineation of management zones!



Application maps based on soil maps, CT scans, smart analysis and AI-based decision trees



- Step 1: Soils maps of the desired area
- Step 2: Smart sampling of soil samples
- Step 3: X-ray CT scanning and analysis of soil fertility status
- Step 4: Derivation of local application maps based on AI decision algorithms
- Step 5: Usage of application maps in agricultural technology

Thank you!



rentenbank