Stocktaking for Agricultural Soil Quality and Ecosystem Services Indicators and their Reference Values

(SIREN)

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EJP SOIL
European Joint Programme

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Background

- EU Biodiversity Strategy
- Farm to Fork Strategy

} New Soil Strategy 2030

- 70% European soils healthy by 2030, all soils by 2050
- Soil Health Law by 2023

→ Common understanding Soil Health

→ Indicators

→ Implemented monitoring systems SH

→ Quantification soil functions/ecosystem services

→ (?) Synchronised with Ecosystem and Biodiversity assessments

SIREN Headlines / the way forward

1. Stocktake of soil data use in ES assessment by EJP SOIL Member States
2. Knowledge gaps and needs towards policy implementation in MS
3. Framework linking Soil Quality to ES, with consistent glossary of key concepts
4. Tiered soil health monitoring system: Tier 1 (”minimum dataset”) > Tier 2 > Tier 3
5. Harmonization of indicators, not methods or references
6. Top-down indicator selection (policy-relevant SQIs for specific policy objectives) rather than bottom-up
7. Stakeholder participation in the development of national monitoring schemes

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Stocktaking for Agricultural Soil Quality and Ecosystem Services Indicators and their Reference Values

1st Internal call EJP SOIL

Project start and end date:	2021-02 to 2022-01
Funding agency / grant scheme:	DG-Agri European Joint Programme COFUND
Overall budget:	360 k€
Coordinated by:	Wageningen Research (sec.: INRAE and SLU)
Number of partners in the consortium:	21
Which countries are in the consortium:	BE, CH, CZ, DK, EE, FI, FR, IE, IT, LT, LV, NL, NO, PL, PT, SE, SL, SK, SP, UK
Overall primary objective:	To establish how the status and functioning of agricultural soils and the provision of ecosystem services is assessed and monitored by the EJP SOIL Member States.

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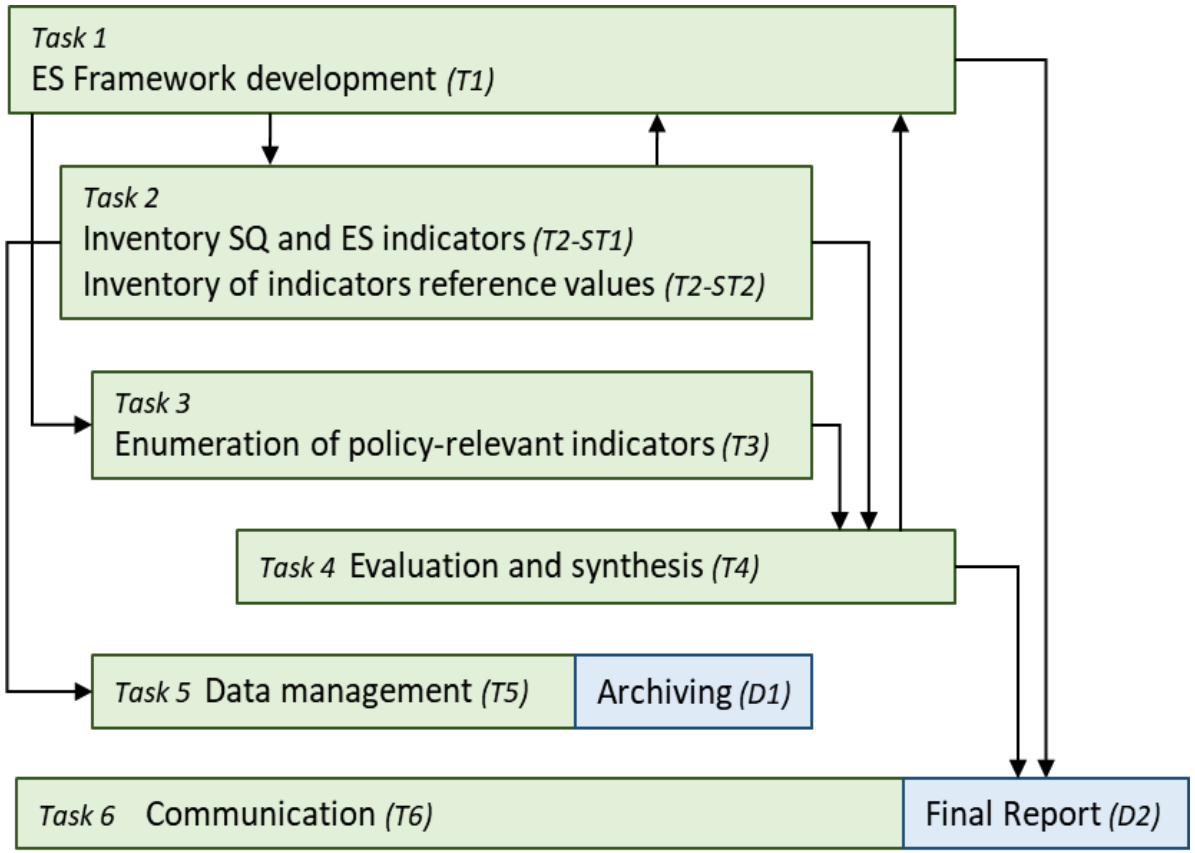
SIREN approach

1. Conceptual framework linking SQ –ES
2. Stocktake 21 Partners
   - SQ data use in ES assessment
   - Reference values for SQIs
3. Literature review
4. Stakeholder views
5. Synthesis



Questionnaire to 21 Partners

A. Conceptual framework (draft)
B. Ecosystem Services assessment based on Soil Quality Monitoring
C. Evaluation criteria; Referencing and targeting soil quality
D. policy relevance and implementation of soil quality-based ES assessment

Knowledge gaps

Development needs towards policy implementation

A conceptual framework to include ES into SQ assessment

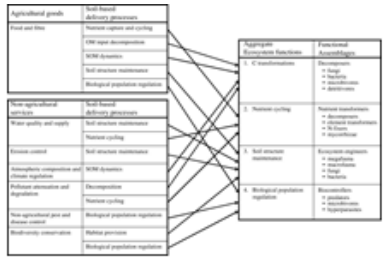
Consistent terminology

Methodology for data handling

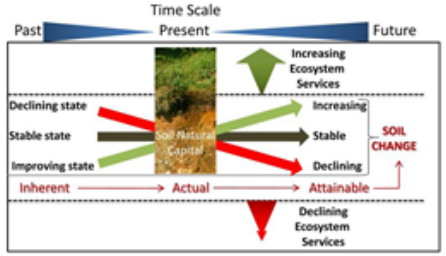
Integration of soils into the ES approach:

- soil functions *(e.g., Adhikari and Hartemink 2016)*
- soil threats *(Schwilch et al. 2016)*
- soils as natural capital *(e.g., Robinson et al. 2009)*
- institutional economics *(Bartkowski et al. 2018)*
- sustainable development goals *(Keesstra et al. 2016)*
- sustainability assessment *(Helming et al. 2018)*

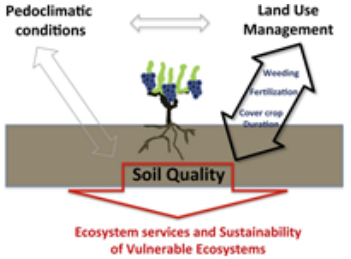
Conceptual frameworks to include ES into SQ assessment



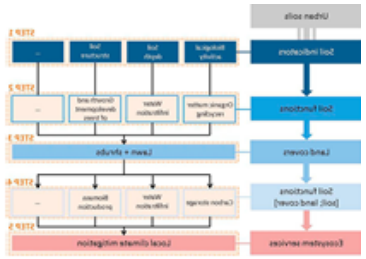
Kibblewhite et al. 2008



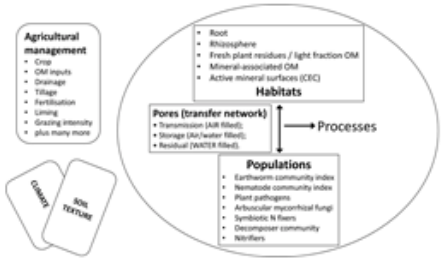
Robinson et al. 2012



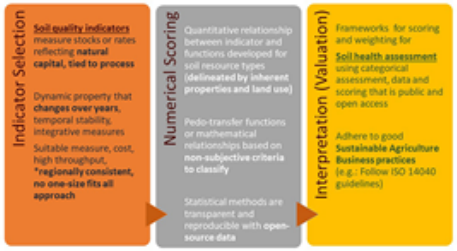
Salomé et al. 2016



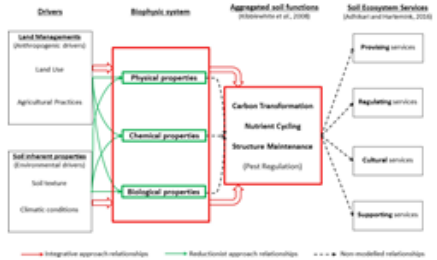
Blanchart et al. 2018



Stockdale et al 2018



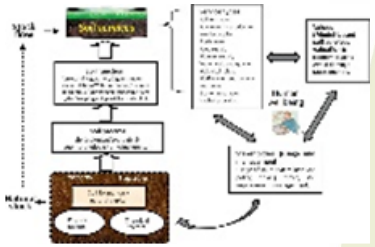
Wander et al. 2019



Thoumazeau et al. 2019

Pavan and Ometto 2018

Lal 2016

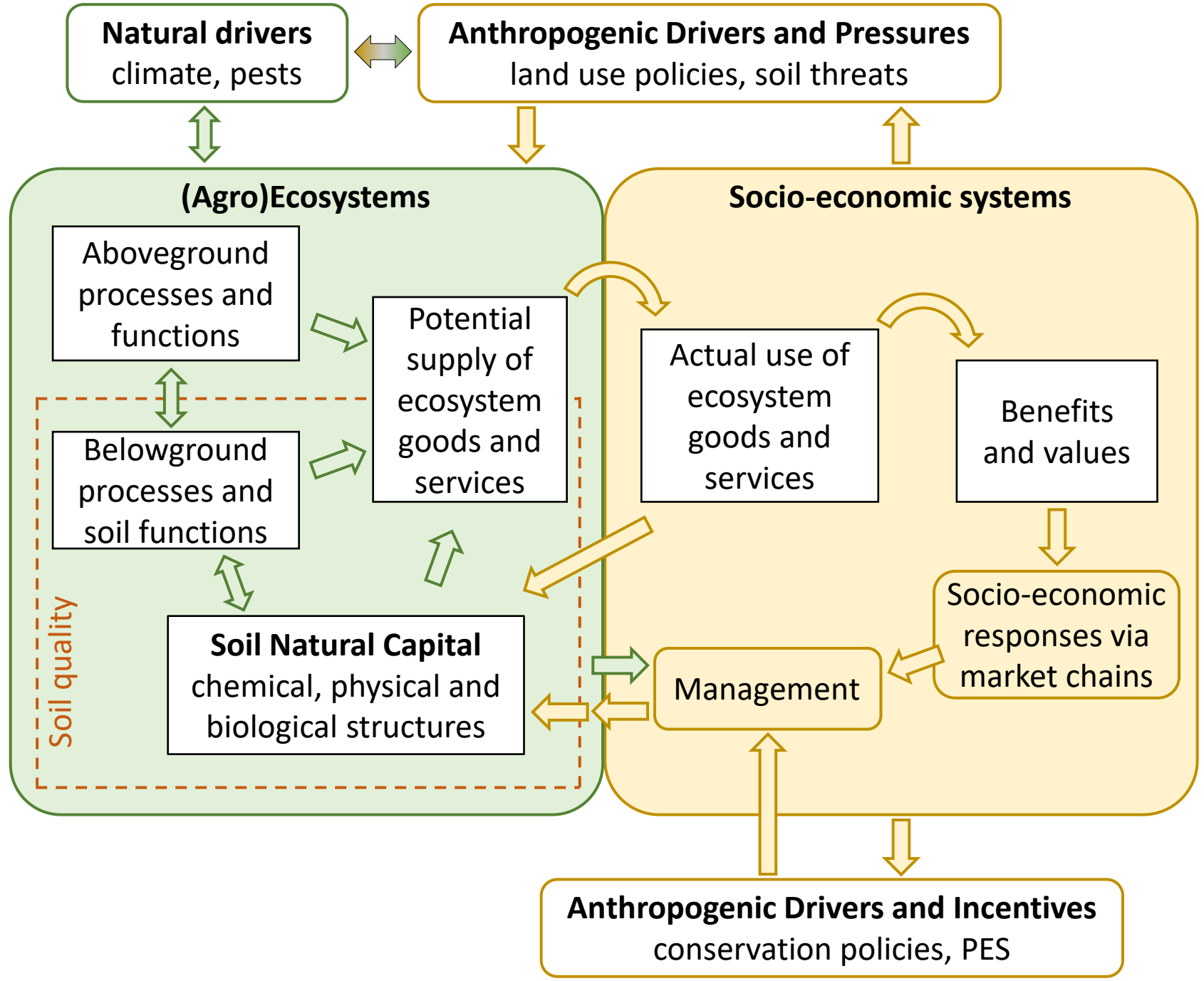


Su et al. 2018

A conceptual framework to include ES into SQ assessment

		Thoumazeau *et al.* 2019	Stockdale *et al.* 2018	Blanchart *et al.* 2018	Pavan and Ometto 2018	Su *et al.* 2018	Salomé *et al.* 2016	Lal 2016
Ecosystem type	Agricultural	✕	✕		✕		✕	
	Urban			✕				
	Other							
	Not specified					✕		✕
Consideration of land management or cover		yes	yes	yes	yes	yes	yes	unspecified
Concept	Soil Security							
	Soil Health		✕					✕
	Soil Quality	✕		✕	✕		✕	✕
	Soil Fertility							
Consideration for:	Soil attributes (or properties/indicators)	✕	✕	✕				✕
	Soil processes		✕		✕	✕		
	Soil functions	✕		✕	✕	✕		
	Ecosystem services	✕		✕	✕	✕	✕	✕
Soil attributes/indicators considered	Physical	✕	✕	✕		✕		✕
	Chemical	✕	✕	✕		✕		✕
	Biological	✕	✕	✕				✕
	"Ecological"							✕
	Contamination			✕				
Difference between final and intermediate ES		no		no	no	no	no	no
Difference between soil processes, functions and ES		yes		yes	yes	yes	no	yes
Differentiation between “manageable” and “inherent” soil properties		yes		no	no	no	no	no
Consideration of ES benefits/values		no		no	yes	yes	no	no

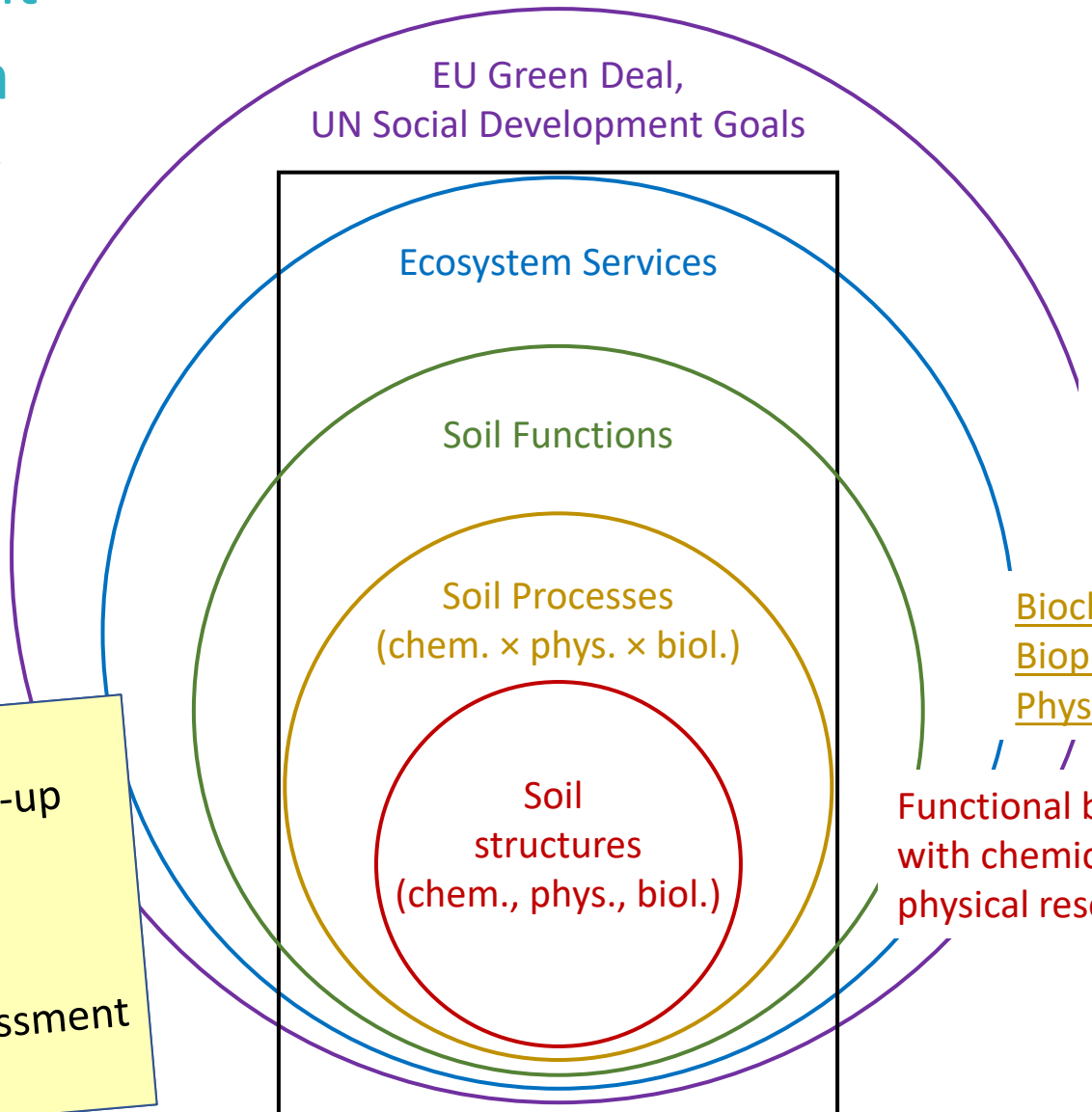
Conceptual Framework



SQ data to assess ES:
potential supply,
not actual use

Management:
to produce more ES,
OR to facilitate efficient use

SQ assessment by integration and upscaling soil data



Healthy soils,
Food security SDG2

Decomposition and fixing processes
(Class 2.2.4.2 in CICES V5.1)

Natural soil fertility, a balance of SOM mineralisation versus humification, and immobilisation vs. mobilisation of nutrients

Biochem.: ammonification, (de-)nitrification,
Biophys.: soil aggregation, bioturbation;
Physicochem.: complexation, adhesion

Functional biodiversity, with chemical and physical resources

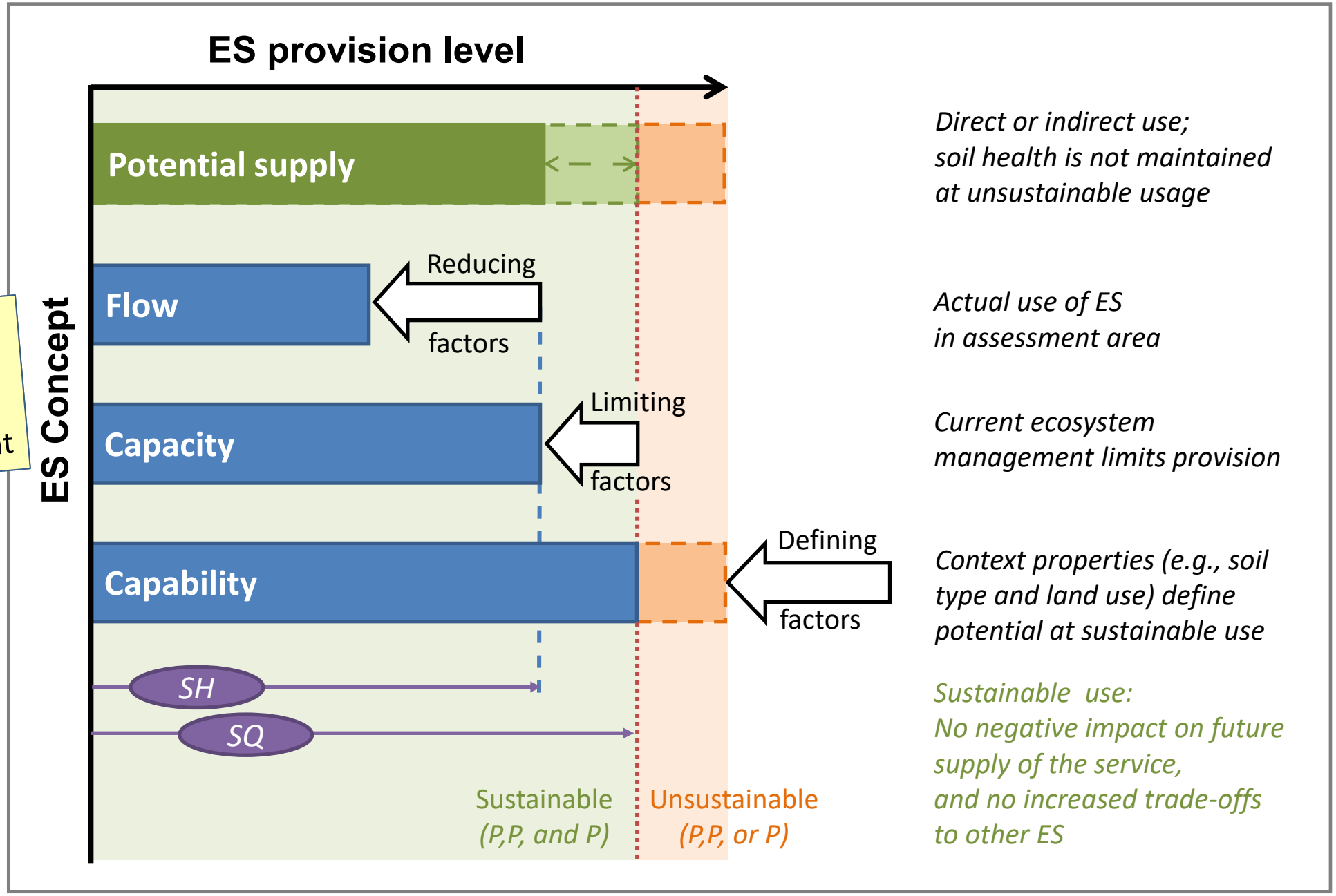
Indicator selection:
Top down, not bottom-up

Guidance is missing

cf. ISO Ecol. Risk Assessment soil contamination

ES-SQ Glossary

Linking SQ data to ES assessment with decision support for adequate management



Direct or indirect use; soil health is not maintained at unsustainable usage

Actual use of ES in assessment area

Current ecosystem management limits provision

Context properties (e.g., soil type and land use) define potential at sustainable use

Sustainable use: No negative impact on future supply of the service, and no increased trade-offs to other ES

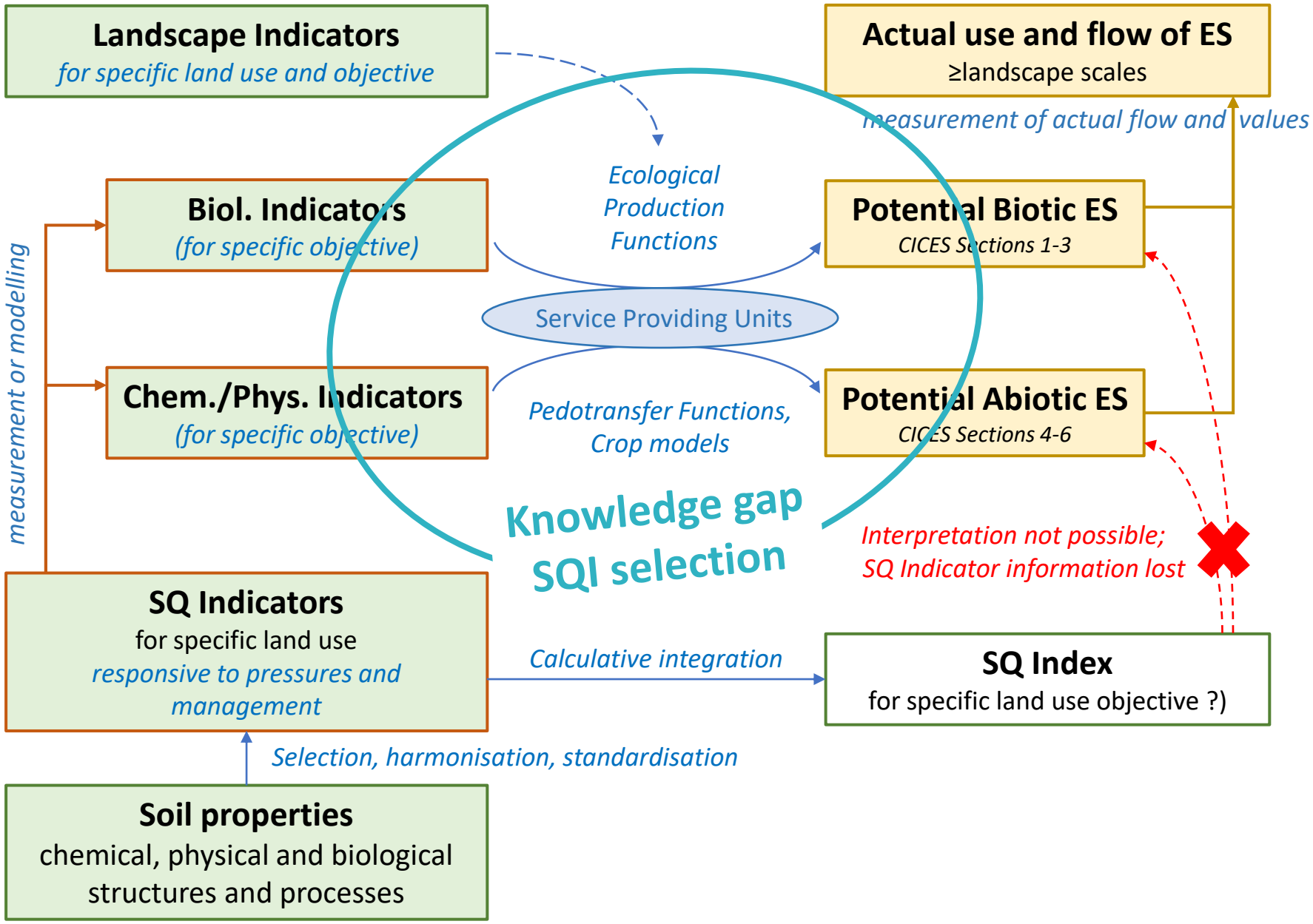
SQ / SH and sustainability

Soil quality is the capacity of a soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity and health, maintain or enhance water and air quality, and to further provide ecosystem services on the long-term without (increased) trade-offs between ES. (After Doran 1996, Karlen et al. 1997, and Giuffré et al. 2021).

Soil Health is then derived from local SQ specifications, and is the actual (current) condition of the soil, as monitored and measured with dedicated indicators.

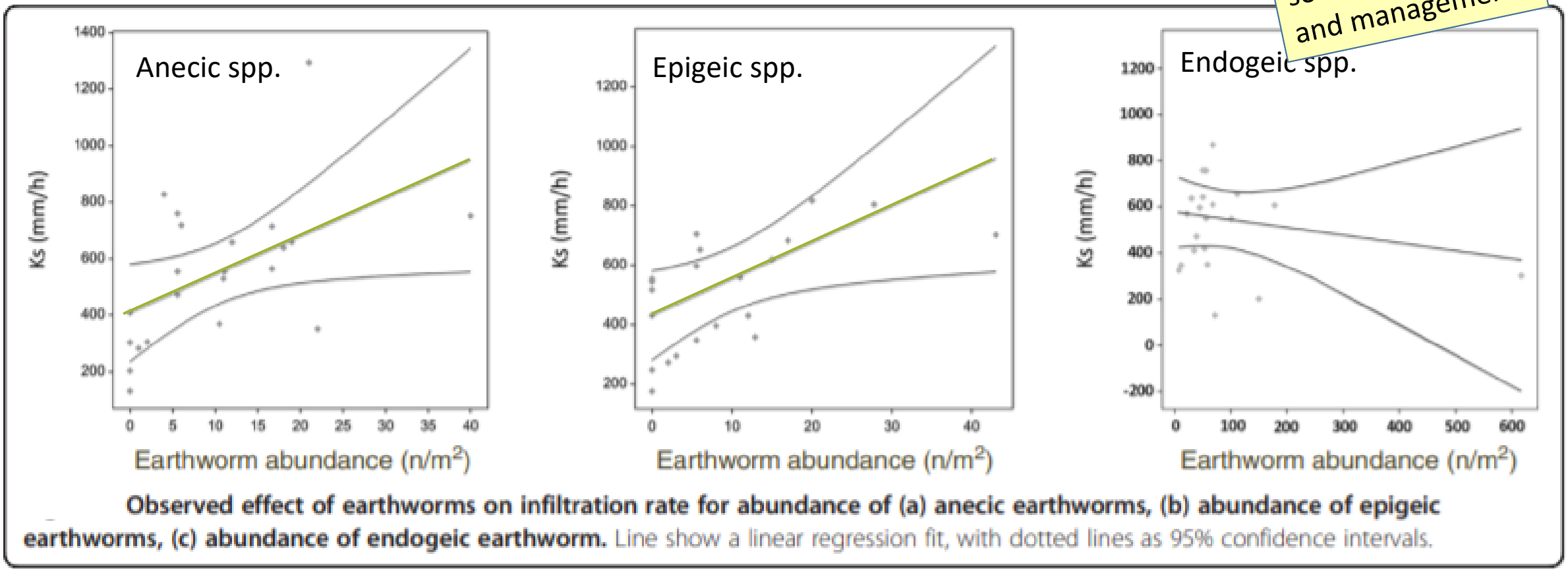
Linking SQ to ES

SQ data to predict ES:
modelling needs
quantified relationships
for scenario studies and
predictive trend analysis



Example EPF: regulation of water infiltration by earthworm groups

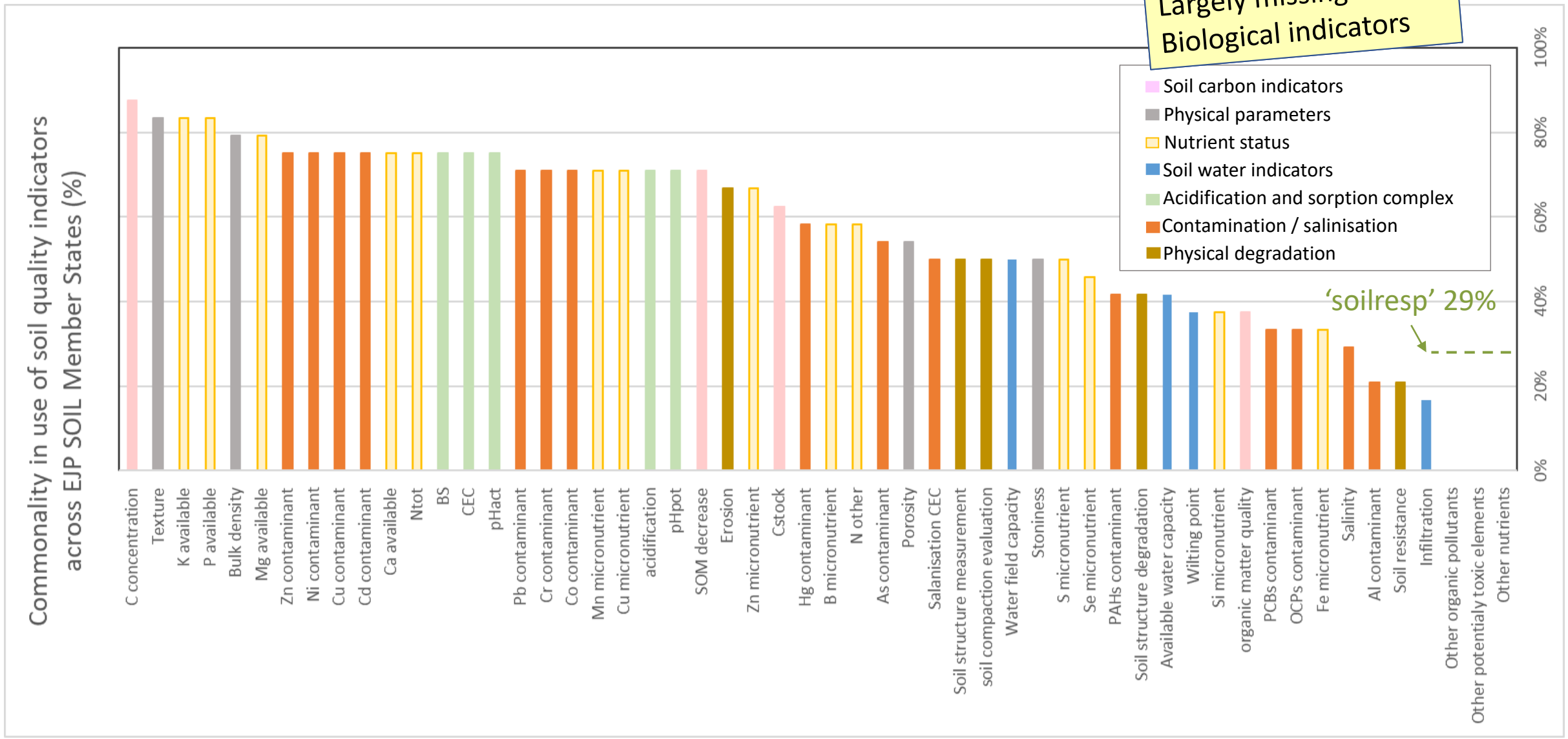
contextualisation: benchmarking for soil type, land use and management



Observed effect of earthworms on infiltration rate for abundance of (a) anecic earthworms, (b) abundance of epigeic earthworms, (c) abundance of endogeic earthworm. Line show a linear regression fit, with dotted lines as 95% confidence intervals.

Spurgeon et al. 2013

SQIs used by MS



Source: T2.4.2 stocktake

SQI criteria in Member States

REFERENCE values
THRESHOLD values
TARGET values

Shortlist “minimum dataset” for harmonised SQ monitoring across Europe

Criteria:

- Policy-relevant
- >50% MS
- >30% sci. literature
- Appl. in EU projects

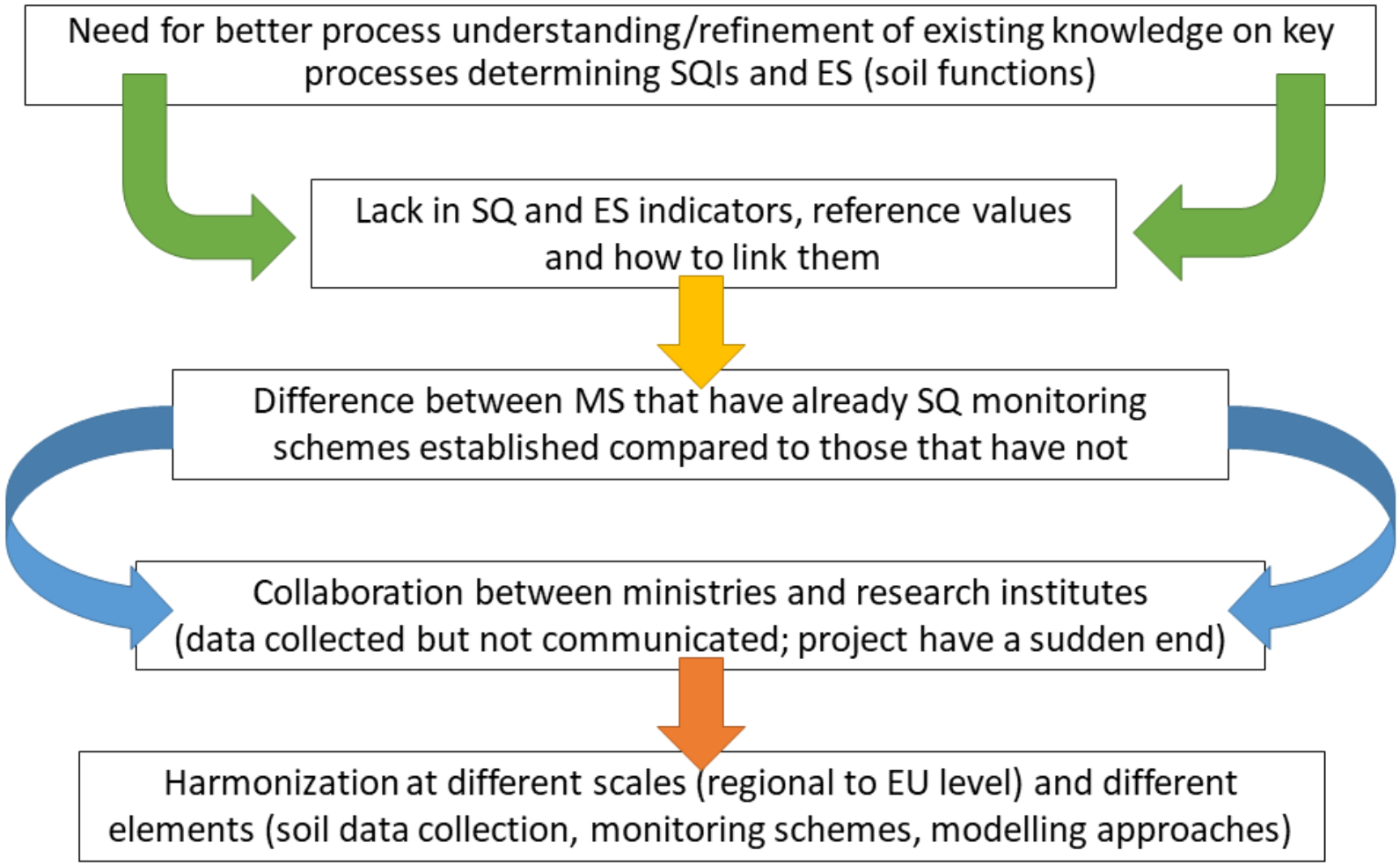
Biodiversity data

- Structural
- Functional

Policy Indicator	Soil Quality Indicator
Soil physical condition	Texture, Porosity, Bulk density
Soil fertility	C concentration Total N P K pH
Erosion evaluation	Based on calculation
Salinity	Electric conductivity
Contamination	Heavy metal trace elements
Other contaminants	*Recommended to be included **
Soil biodiversity	
Water regulation	

** Based on our selection strategy, we observed significant omissions regarding indicators for soil biodiversity, organic contamination and water regulation/filtration. As soil condition data in these areas are called for by policies and stakeholders and (standardised as well as novel) methods are scientifically available, we recommend to also include relevant indicators in this 1st tier minimum dataset. Based on our stocktake and reviews it is yet impossible to select any without making subjective choices, which is what we wanted to avoid.*

Partners' key needs for knowledge development, knowledge transfer, and policy implementation



General conclusions from stocktaking

1. SQ monitoring under ecosystem health-focussed policies urgently need a commonly accepted comprehensive conceptual framework with related descriptive concepts and clear definitions, both for scientific research and policy implementation. *Eur. Soil Health Law*

2. Partners' ES assessment: - to assess status and functioning of ecosystems under environmental change
   - to inform decision-making in spatial planning or payments for services

   Soils mostly theoretically considered by soil functions (or "soil quality" as a specific function), SQIs poorly specified in National Ecosystem Assessment reports, evaluation unclear.

3. MS do not widely use SQI data to assess ES.
   ES classification generally based on CICES, or modification.
   Largest commonality between MS is soil organic carbon (stock, changes).
   Omissions for parameters re. soil biology, water regulation and organic contaminants.

General conclusions from stocktaking – *cont'd*

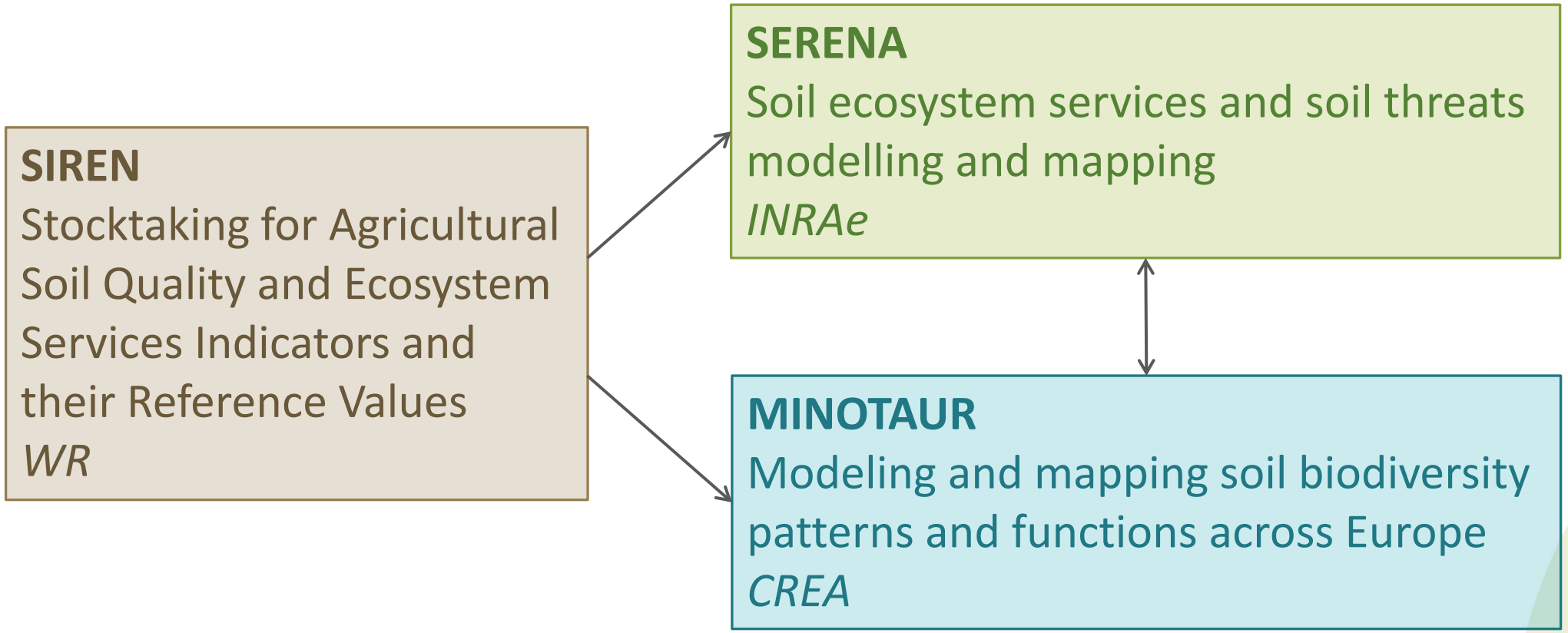
4. ES concept incorporated in policy by few MS, for a limited number of ES (never integrated full range.
   Challenges for implementation diverse and highly variable.
   Top common priorities:
   - Development + enforcement nat. soil monitoring program
     (if non-existent or deemed insufficient for ES assessment)
   - Develop NEA using SQI data
   - References and target values to interpret ES assessments

5. The implementation of biological indicators in national soil monitoring is scarce and insufficient to monitor status of structural biodiversity (e.g., species richness) and to assess functional aspects in the provision of ES. Indicators for soil water regulation and organic contaminants also lack representation in most countries' surveys.

6. SQI evaluation criteria not implemented in all MS
   (contaminants and nutrients, rather than soil functions relating to ES provision.

7. EJP SOIL MS support harmonised SQ monitoring, not standardisation or evaluation.

Follow-up in EJP SOIL



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