Gian Luca Bagnara, Andrea Mattia Pacifico, Giulio Malorgio

NETSOB Working Group 3: economics of soil biodiversity

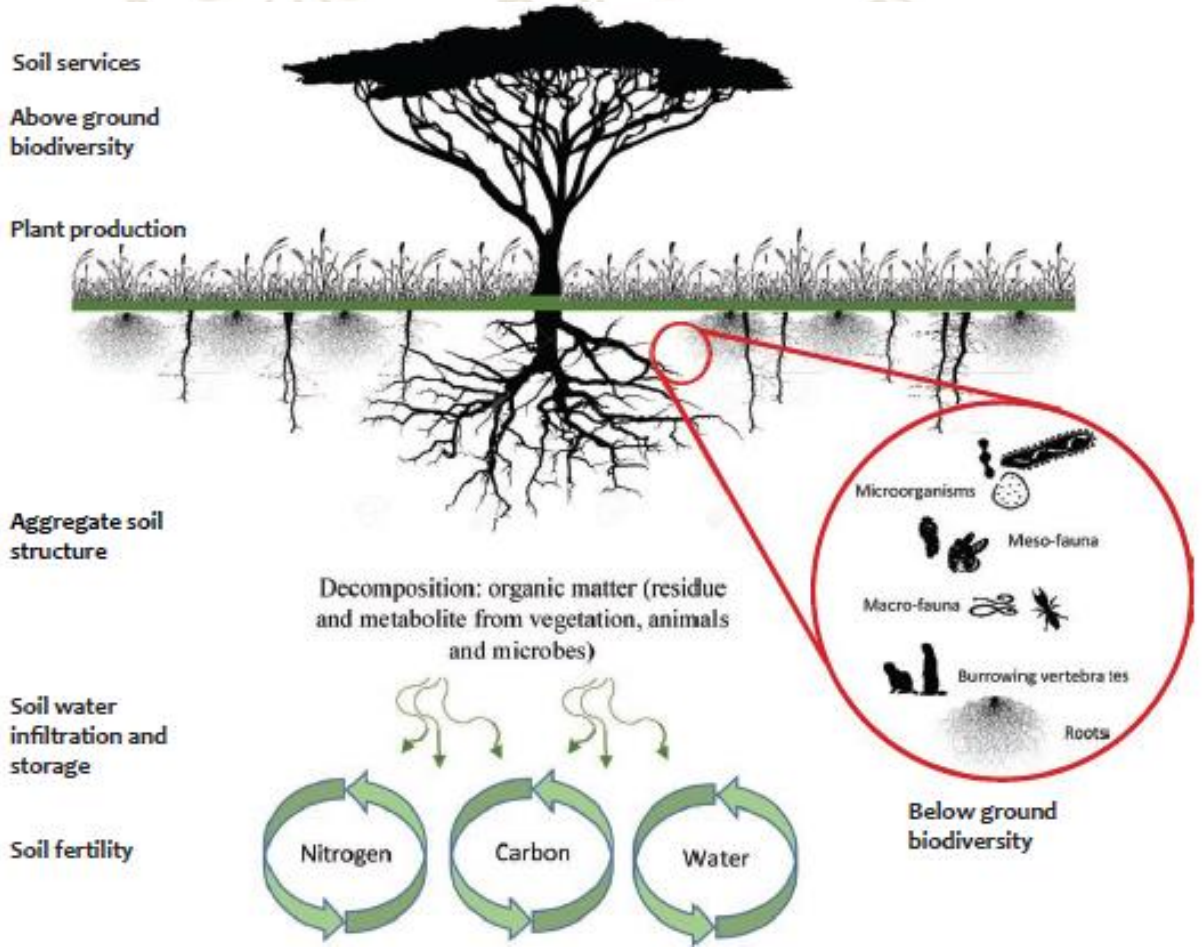
Key points

a. Why is biodiversity valuable

b. Soil biodiversity, soil organic matter and soil organic carbon: overview

c. The importance of soil biodiversity for ecosystem services

d. Ecosystem services and disservices provided by soil organisms in agroecosystems



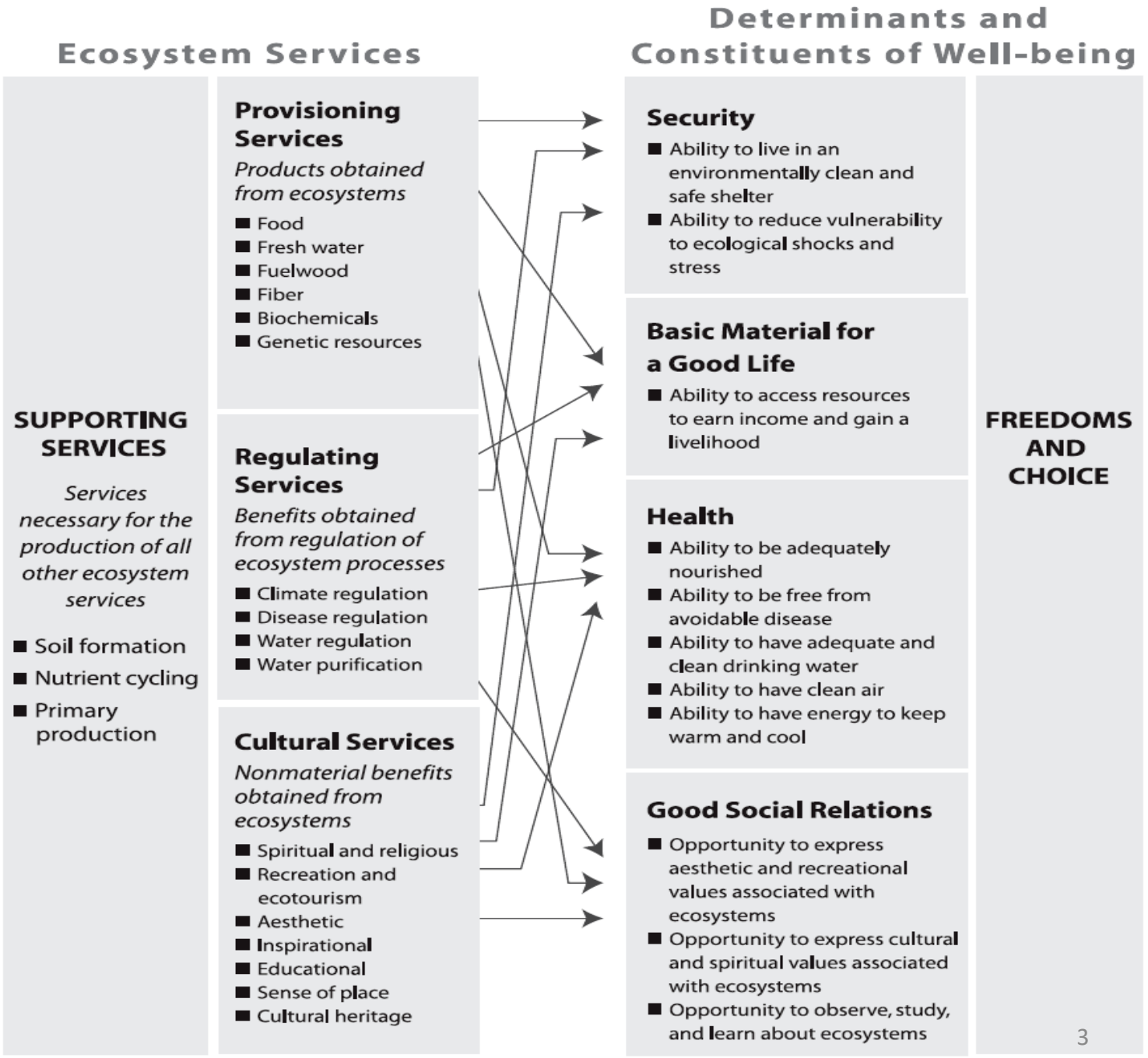
P.Laban,et al. 2018. *Soil Biodiversity and Soil Organic Carbon.* IUCN

WG 3: economics of soil biodiversity

Obj.:

-The importance of soil biodiversity for ecosystem services

- Development of the methodology for the economic valuation of ecosystem services provided by soil biodiversity



Relationship between SOC and key societal needs and soil functions

Societal need	Soil function	Impact
Biomass	Wood and fibre production	+
	Growth of crops	+
Water	Filtering of contaminants	+
	Water storage	+
Climate	Carbon storage	+
Biodiversity	Habitat for plants, insects, microbes, fungi	+
Infrastructure	Platform for infrastructure	Indifferent for mineral soils ([a])
	Storage of geological material	Indifferent

Note: ([a]) SOC-rich soils (e.g. drained organic soils in estuaries) are unstable and unsuitable as a platform for construction because of subsidence and natural changes of the soil's drainage status (Trepel, 2015).

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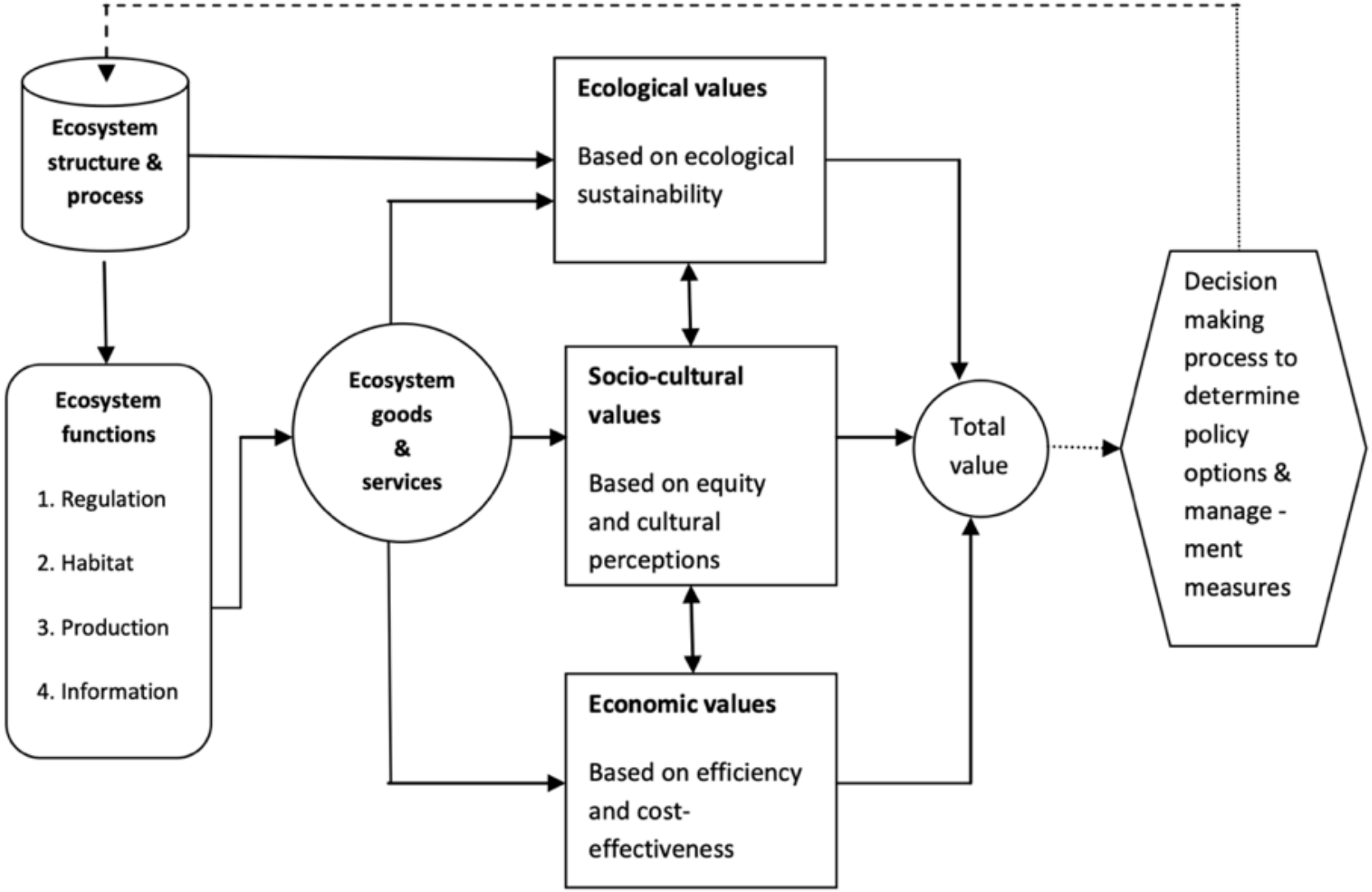
([14]) Decomposition of organic nitrogen in SOC-rich soils during phases of reduced nitrogen uptake by plants (e.g. after harvest) can be accompanied by nitrate losses.

Conceptual framework of the evaluation of Ecosystem services

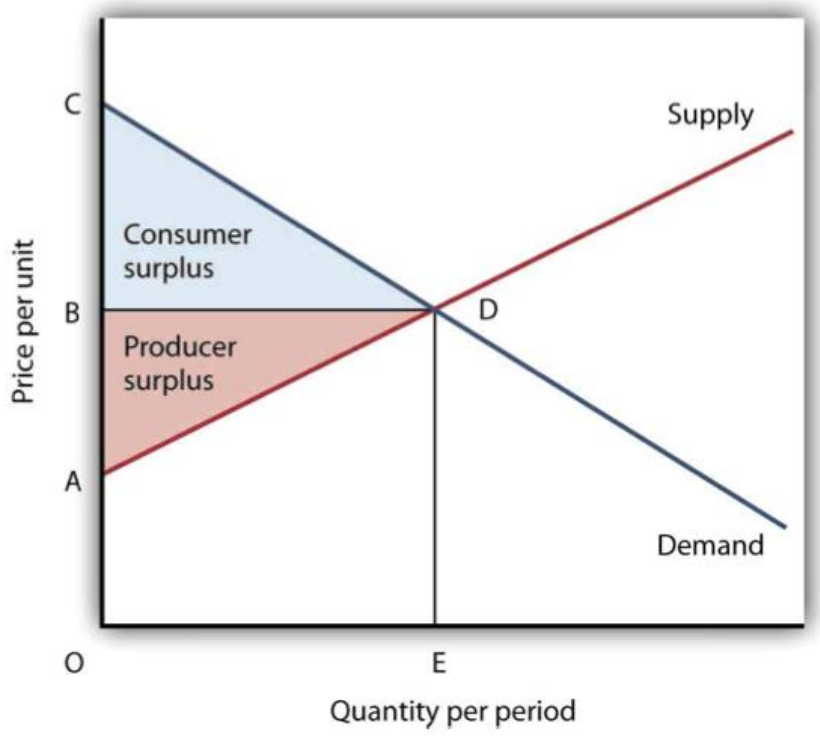
Economic valuation is not the same as pricing a particular element being studied.
The main aim is to assess changes in the net benefits provided by ecosystem services or to compare the possible outcomes of scenarios involving changes in human activities :

- Assess the costs and benefits of an action or policy to aid decision making;
- Improve awareness of the value to society of the benefits provided by an ecosystem or multiple linked ecosystems.



Supply and demand curves for a hypothetical good or service

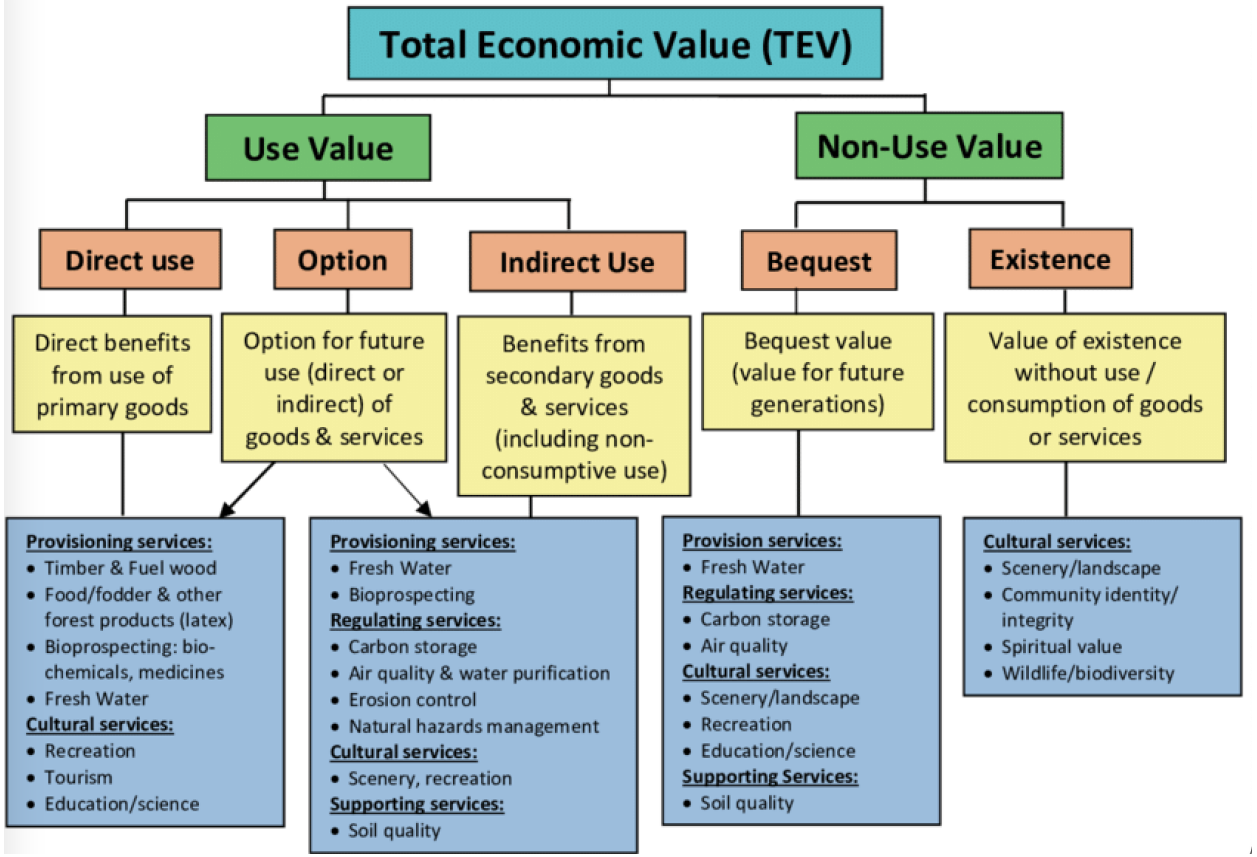
- Consumer surplus = consumers' maximum willingness to pay (WTP) for a service - what they actually pay



Source: Rittenberg and Tregarthen, 2009

Structure of the total economic value

- The economic valuation of ecosystem services (TEV)
  - Non-monetary valuation techniques
    - structured survey techniques based on questionnaires,
    - interviews and focus groups
  - Monetary valuation techniques estimate societal preferences:
    - Willingness to Pay (WTP): the maximum monetary amount an individual is willing to pay for a given benefit from ecosystem services, or for a change in their quantity/quality;
    - Willingness to Accept (WTA): in the case of negative changes in the provision of a given ecosystem service, representing the maximum monetary amount an individual is willing to give up for a change in the provision of a given good or service.



Source: DEFRA, 2007

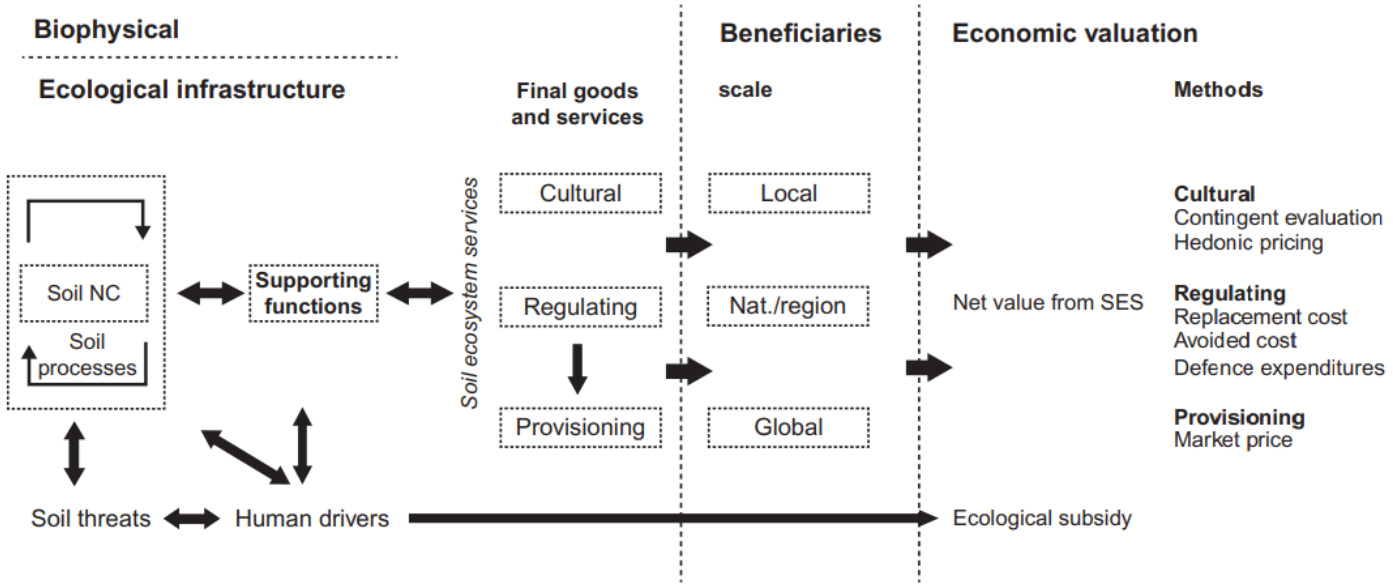
Techniques for economic valuation of ecosystem services

Category	Methods	Note
Direct market valuation	• Market price • Market proxy • Production function • Avoided cost • Replacement cost • Damage cost	Methods based on markets and production processes. Limitations: Since these methods rely on market transactions, in cases where markets do not exist, there may be a lack of data that does not accurately reflect market reality.
Revealed preferences	• Travel cost • Hedonic price	Methods based on revealed values from behavior in associated markets. Limitations: Due to market imperfections, the monetary value of services can be distorted. Reliable and representative data is required.
Stated preferences	• Contingent valuation • Choice experiment	Methods based on surveys where respondents evaluate different scenarios. Limitations: These methods can be costly and technically challenging to implement, and they are prone to biases and distortions.

Economic valuation of soil biodiversity

- The TEV of soil biodiversity is associated with two categories of soil ES:
  a. in-situ soil services having a private good feature
     - such as water control and nutrient cycling, that allow the production of consumable products, such as crops;

  b. ex-situ soil services having a public benefit component that express beyond the geographical boundaries under land user control
     - Soil biodiversity plays a crucial role in regulating services by effectively sequestering carbon dioxide (CO2) and releasing oxygen (O2)



Soil ecosystem services framework (Jónsson et al., 2017)

Valuation methods for specific soil-based ecosystem services

ES -ecosystem services	Economic valuation method	Reference
Food provision, raw materials	Market price	Fan et al., 2016; Sanshu et al., 2008
Carbon sequestration	Market price; social cost of carbon	Mekuria et al., 2011; Porter et al., 2009; Sandhu et al., 2008
Nitrogen and Phosphorous improvements	Market price	Mekuria et al., 2011;
Soil formation	Replacement cost	Sandhu et al., 2010; Sandhu et al., 2008
Soil fertility	Market price	Sandhu et al., 2008
Mineralization of plants nutrients	Market price	Sandhu et al., 2010; Sandhu et al., 2008
Erosion control	Replacement cost; choice experiment	Kassie et al., 2008; Colombo et al., 2006;
Gas regulation	Market price	Xiao et al., 2005
Biological control of pests	Avoided cost	Porter et al., 2009; Sandhu et al., 2008
Pollination	Market price	Sandhu et al., 2008

An application

- Is C_{org} an indicator / proxy of biodiversity in soil ?
- Worldwide currency: CO2 ?
  To be discussed with WG1 and WG2

Value of soil carbon accumulation via improved agricultural management (**e_{sca}**) in terms of g CO_2eq/MJ:

(source: Commission Implementing Regulation (EU) 2022/996)

$$e_{sca} = (CS_A - CS_R) \times 3{,}664 \times 10^6 \times \frac{1}{n} \times \frac{1}{P} - e_f$$

Where:

CS_R	is the mass of soil carbon stock per unit area associated with the reference crop management practice in Mg of C per ha.
CS_A	is the mass of soil estimated carbon stock per unit area associated with the actual crop management practices after at least 10 years of application in Mg of C per ha.
3,664	is the quotient obtained by dividing the molecular weight of CO_2 (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) in g CO_{2eq}/g C.
n	is the period (in years) of the cultivation of the crop considered.
P	is the productivity of the crop (measured as MJ biofuel or bioliquid energy per ha per year).
ef	emissions from the increased fertilisers or herbicide use

Thank you

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