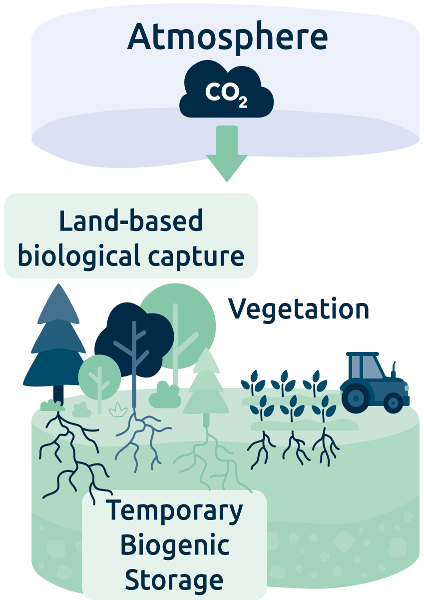
Soil Carbon Sequestration

NEGEM

A practice which enhances a natural process to store CO_2 and can reduce emissions



Expected permanence	decades
Reversal risk	high
Uncertainty in amount of initially captured carbon	medium
Uncertainty in amount of carbon stored over time	high
Ease of MRV	low
Key co-benefits	Enhances soil resilience, water retention and contribute to ecosystem integrity

What is soil carbon sequestration and how does it store carbon?

Soil organic carbon (SOC) sequestration occurs because plants capture atmospheric CO_2 by photosynthesis and convert it into organic carbon. Part of this organic carbon is then transported into soils, thereby increasing the soil organic carbon content. Sustainable management practices such as conservation tillage, cover cropping, plant/crop variety, organic amendments (e.g. compost or manure), and drastic reduction in synthetic fertilisers help to retain organic carbon in soils and maintain or restore soil health and stability.

Measures that enhance SOC are common practice within sustainable land management due to the resulting co-benefits that secure the livelihoods of farmers. Yet, as an activity-lead practice, stored carbon is not commonly quantified, and will likely vary depending on the particular ecosystem and geographical location conditions. Numerous habitats contain substantial amounts of organic carbon such as agricultural soils, forests, wetlands, and grasslands, but soil carbon content is unevenly distributed across Europe; northern countries tend to be carbon-rich whereas the Mediterranean region is carbon depleted. Despite a clear value to society, around two-thirds of EU soil ecosystems are in poor health, acting as an emissions source, as opposed to a sink. Continuous land management and consistent policy measures are necessary to support carbon retention in soils.

Relevant regulatory frameworks: Soil Monitoring Law (under negotiation), Common Agricultural Policy, Nature Restoration Law, Regulation on an EU certification for carbon removals

ADVANTAGES

IMPROVES SOIL HEALTH

Addressing SOC will improve soil quality and resilience and promote nutrient cycling in terrestrial ecosystems.

ADDRESSES A HIGH EMISSION SECTOR

Adequate implementation of sustainable land management practices in agriculture could cut emissions in a top polluting sector.

MULTIPLE CO-BENEFITS

Healthy soils fulfill societal needs such as food security, healthy ecosystems, and water storage.

CHALLENGES

RISK OF STORAGE REVERSAL

SOC storage is vulnerable to disturbances that can reemit stored carbon.

LIMITED STORAGE CAPACITY

Biophysical constraints such as rainfall impact on vegetation growth rates, can reduce soil carbon sequestration capacity.

CONTINOUS MANAGEMENT

Inadequate land management or transfer of land stewardship can transform soils into a carbon source, as opposed to a carbon sink.

ACCURATE QUANTIFICATION OF CARBON

Land management practices, soil types and climate conditions have different impacts on the soil carbon cycle. This complicates MRV and the design of methodologies.

What is the sustainable potential of soil carbon sequestration?

Economic performance

CapEx
May be low unless purchase of equipment necessary e.g. for conservation tillage or composting/infrastructure changes, especially when no support system for land stewards exists.

OpEx
Sustained monitoring, maintenance costs as well as labour for land management practices.

Environmental performance

Limitations on soil organic carbon storage capacity.

Impacts of climate change may increase storage vulnerability.

Estimated scale and cost (2050)

0.6-9.3 $GtCO_2$/yr
$-45-100/$tCO_2$

Resource security

Not relevant, if implemented on existing agricultural or forestry land.

Social and governance performance

Healthier soils boost food security, human health, and farmer livelihoods.

High risk of contractual reversal. Success is highly dependent on agricultural policies and practices.

Current unknowns and future research perspectives

SOC content impacts soil function, and above a certain threshold, further increases ceases to benefit the ecosystem. Further research is needed to establish these thresholds.

Influence of soil type, climate (e.g. change in rainfall patterns, rising sea levels, erosion) and management practices on SOC content. The realistic long-term capacity and potential of SOC sequestration long-term is not well understood.

Policy recommendations

Establish legally binding targets and sustainable management practices across all habitats, that focus on protection, restoration and soil health, including its role in regulating water, air quality, assuring food production and supporting biodiversity; focus policy on enhancing ecosystem integrity, while designating associated carbon sequestration as the co-benefit.

Reform the Common Agricultural Policy to set higher targets, combining both activity and results-based goals, regenerative practices, and prevention of further degradation of soils and carbon stocks; apply tighter conditionalities that favour small scale farms, and provide training, technical support, and advice to farmers.

Shift dietary preferences towards a plant-based diet and adopt policies that seek to reduce food waste.

Develop a standardised accounting, MRV and liability system, tailored to the different climate conditions and soil type, if the practice is incentivised by carbon removal units.

Create detailed databases, including land use data, to measure and monitor soil systems and their health, including their baselines; develop remote sensing and other machine learning techniques.

Relevant literature

- The Land Gap Report, update 2023
- IPCC Special Report on Climate Change and Land, 2019
- NEGEM Deliverables: D1.2, D2.2, D8.1

negemproject.eu

Funded by the European Union

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 869192.