

The International Seminar at Czestochowa University of Technology
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Environmental safety of biosolids in the circular economy

Soil carbon sequestration under sewage sludge soil treatment

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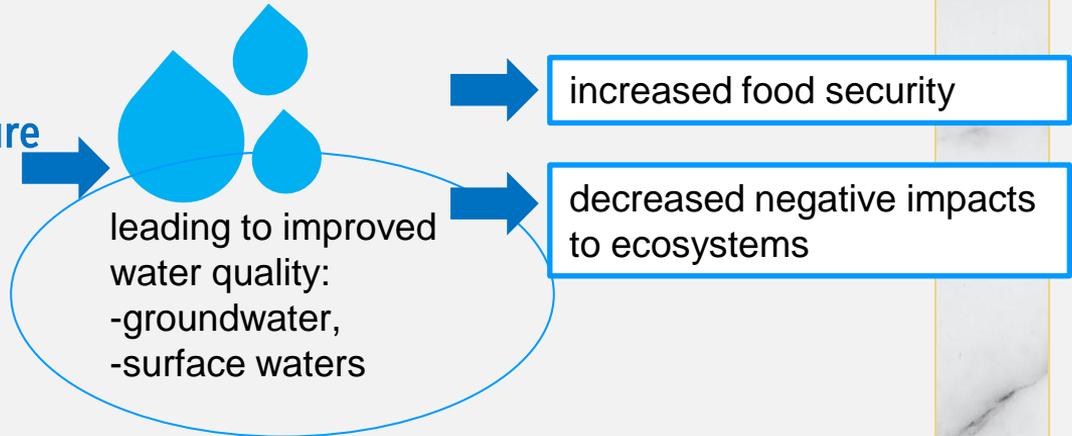
Soil organic matter is a key component of soil that affects its **physical, chemical, and biological properties**, contributing greatly to its proper functioning.

Benefits of soil organic matter (SOM) include

- **improvement of soil quality**
 - through increased retention of water and nutrients, resulting in **higher productivity of plants** in natural environments and agricultural settings.

SOM:

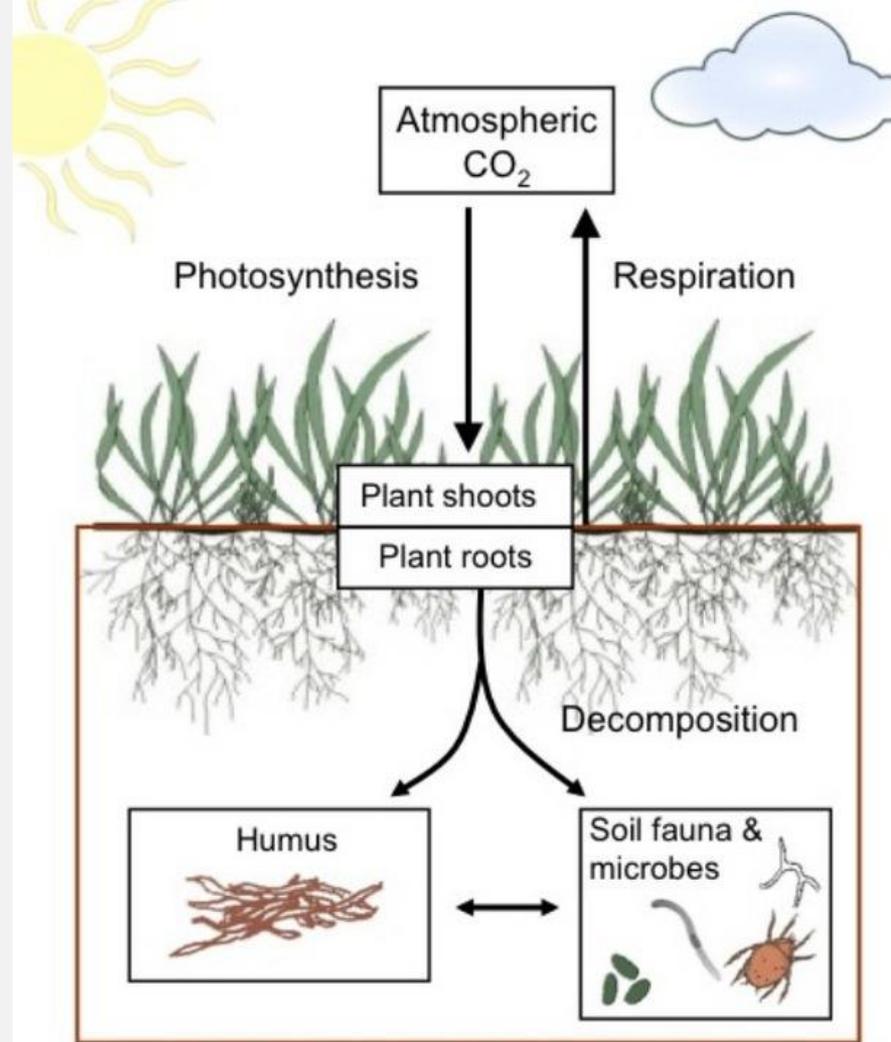
- **improves soil structure**
- **reduces erosion**



Soil carbon sequestration

- process in which CO_2 is removed from the atmosphere and stored in the soil carbon pool
 - Thus, carbon sequestration is a method of reducing CO_2 concentration in the atmosphere and leading to mitigate of climate change.
- is primarily mediated by **plants** through **photosynthesis**, with carbon stored in the form of SOC.

Increased plant growth will in turn facilitate the development or better **soil structure** and **aggregation**.



- ❑ The problem of CO₂ emission is one of the major social concern worldwide;
- ❑ The atmospheric enrichment with CO₂ and other GHGs has resulted in multiple negative consequences: such as the **increase in the average temperature** and **the rise of the sea level**.
- ❑ CO₂ has a potential to **increase global warming by about 60%** (Torri et al., 2014);
- ❑ According to the 2020 Climate & Energy Package (Directive 2009/28/EC of the European Parliament and of the Council) and Strategy Europe 2020, European countries are obligated, among others, **to cut greenhouse gas emission by -20% until 2020**.

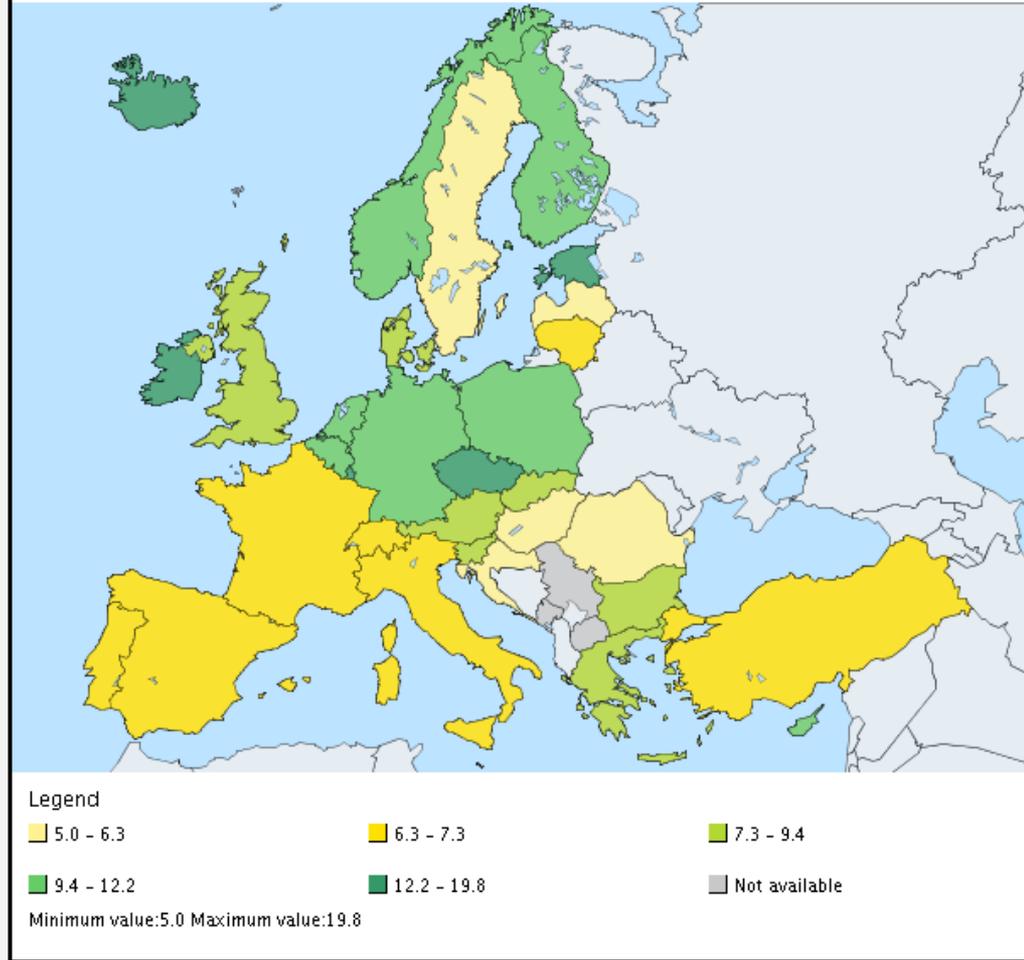


Figure 1. Greenhouse gas emission per capita in EU-28. Mg of CO₂ equivalent per capita- 2016 (Euro stats, 2016).

It has been reported that soil has a high potential for stable and safe carbon storage (Torri et al., 2014)

Soil organic carbon sequestration strongly depends on soil texture, profile characteristic and climate. **However, it is necessary to understand all processes in global carbon cycle, since soil emits GHGs by respiration of soil organic matter.**

Sequestered carbon may be stabilized and stored in the soil *via* many mechanisms



Physical

in soil aggregates, unavailable for organisms



Chemical

via absorption to clays or chemical bonds, unavailable for organisms



Biochemical

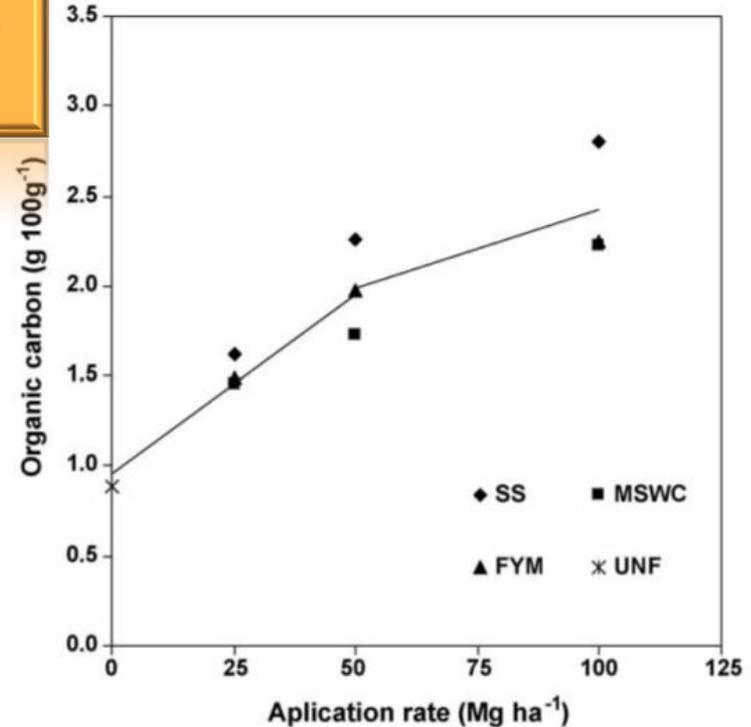
biologically re-synthesized to complex molecule structures that are difficult for decomposition

Many studies have shown higher plant biomass production in soils treated with biowaste (e.g. Torri et al., 2014; Angelini et al., 2005).

- ❑ Placek et al. (2017a) found increase of SOC in soil amended by lake chalk and other biowastes.
- ❑ Meena et al. (2016) also noticed increase of SOC by application of a municipal waste compost to a soil.
- ❑ **Application of sewage sludge** from food industry to soils from zinc smelter and coal mine showed **higher SOC content after 18 months**. The beneficial effects of biowaste in this experiment was assigned to the **immobilization of toxic heavy metals** in the soil allowing for proper growth and development of plants and soil activity, and **finally increased SOC** (Placek et al., 2017b).

SOC

- Hemmat et al. (2010) studied a **long-term impact** of **biowaste** (municipal solid waste compost, sewage sludge and farmyard manure) on soil quality including **SOC of a calcareous soil**.
- They showed that application of all tested biowastes, significantly **increased SOC content after 7 years of experiment**. Moreover, they noticed a close relationship between the rates of biowaste application and SOC increase rate.



Effect of application rate of manures on soil organic carbon content (SOC); SS: sewage sludge; MSWC: municipal solid waste compost; FYM: farm yard manure; UNF: control. (Hemmat et al., 2010).



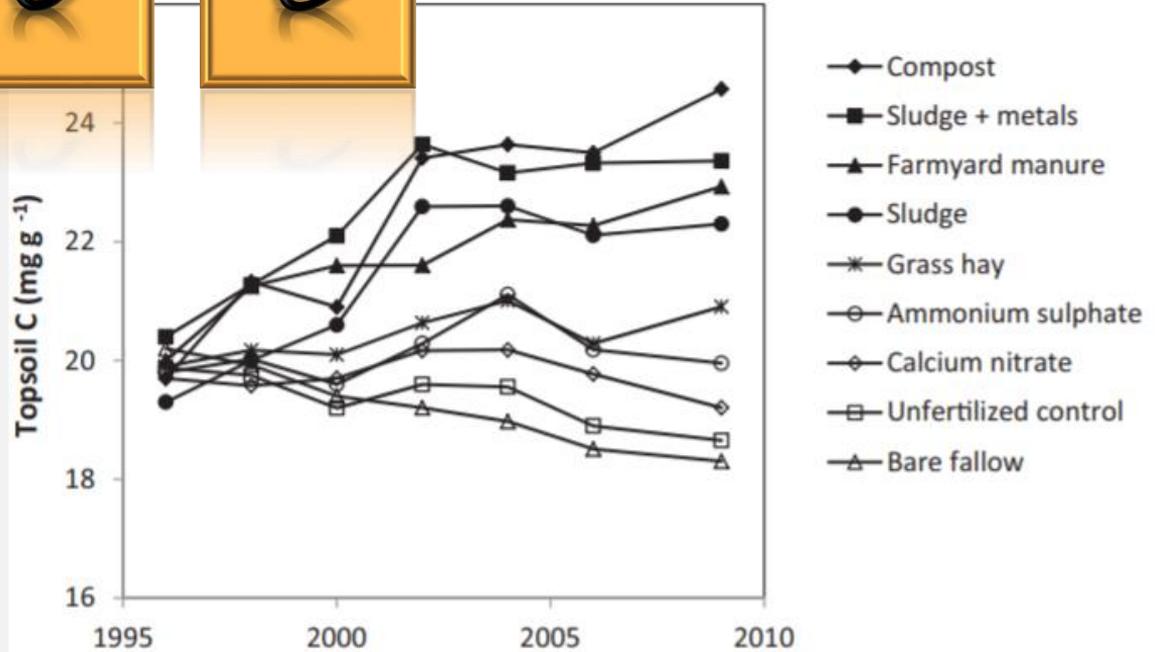
- ❑ **compost produced from town wastes and sewage sludge** showed **beneficial** effects on **SOC in loamy and clay soils** (Aggelides and Londra, 2000)
- ❑ Similarly, Hemmat et al. (2010) found increased SOC after compost application.
- ❑ Tian et al. (2009) calculated a mean **net soil C sequestration of 1.73 Mg C ha⁻¹ year⁻¹ derived from a 34-year reclamation** using sewage sludge on strip-mined lands.

S

O

C

- Kätterer et al. (2014) noticed that **the highest increase of SOC in 0-25 cm deep soil achieved by application of compost after 15 years.**



Carbon concentration in topsoil (0–25 cm) over time in the Lanna experiment (Kätterer et al., 2014)



- ❑ However, in some studies the **effect of sewage sludge** application **depended on initial SOC value**
 - ❑ the application of sewage sludge to a soil with **high initial SOC concentration** resulted in the **decrease of SOC** (Soriano-Disla et al., 2010).
- ❑ On the other hand, sewage sludge application to **60 agricultural soils** **showed an increase of short-term SOC pool** in majority of the soils. (Soriano-Disla et al., 2010).

Conclusions

- ❖ *SOC is a vital component of soil with important effects on the functioning of terrestrial ecosystems.*
- ❖ *Biowaste such as sewage sludge have shown a high potential for carbon sequestration and its storage in the many types of soil.*
- ❖ *Soil carbon sequestration may contribute to the mitigation of climate change.*

This presentation consists a part of a review :
**„Effect of biowastes on soil remediation, plant productivity and soil
organic carbon sequestration”**

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Thank you

for the attention
