Wheat straw hydrochar induced negative priming effect on carbon decomposition in a coastal soil

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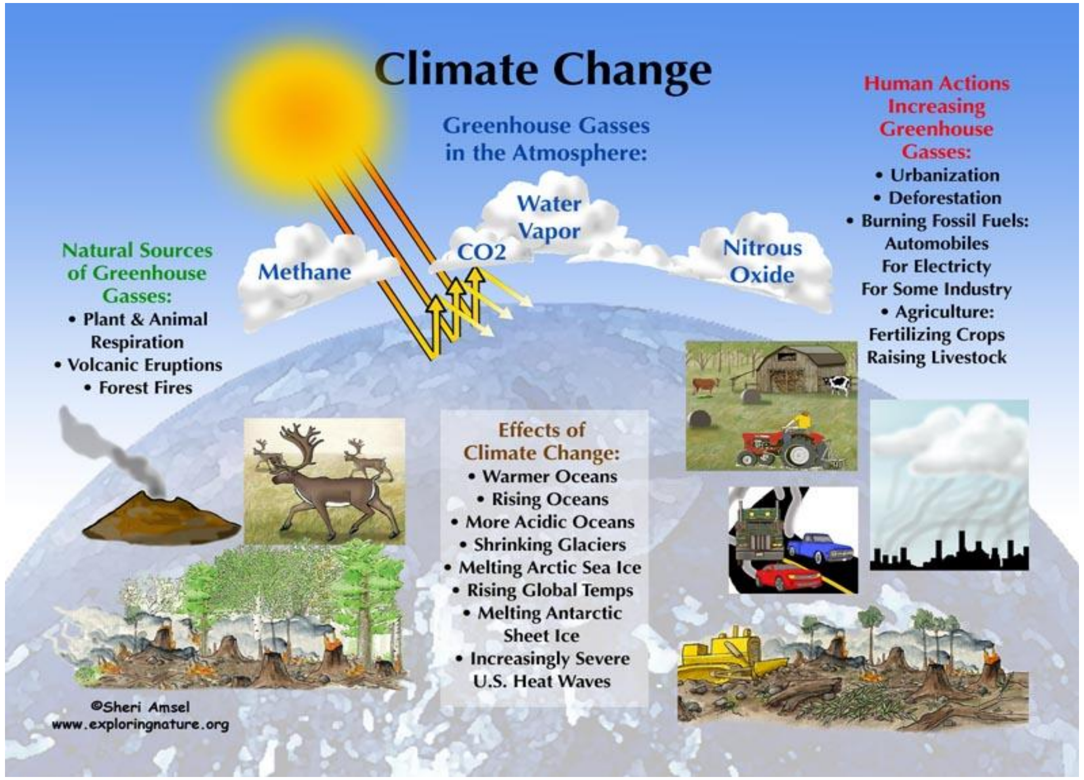
Presentation Outline

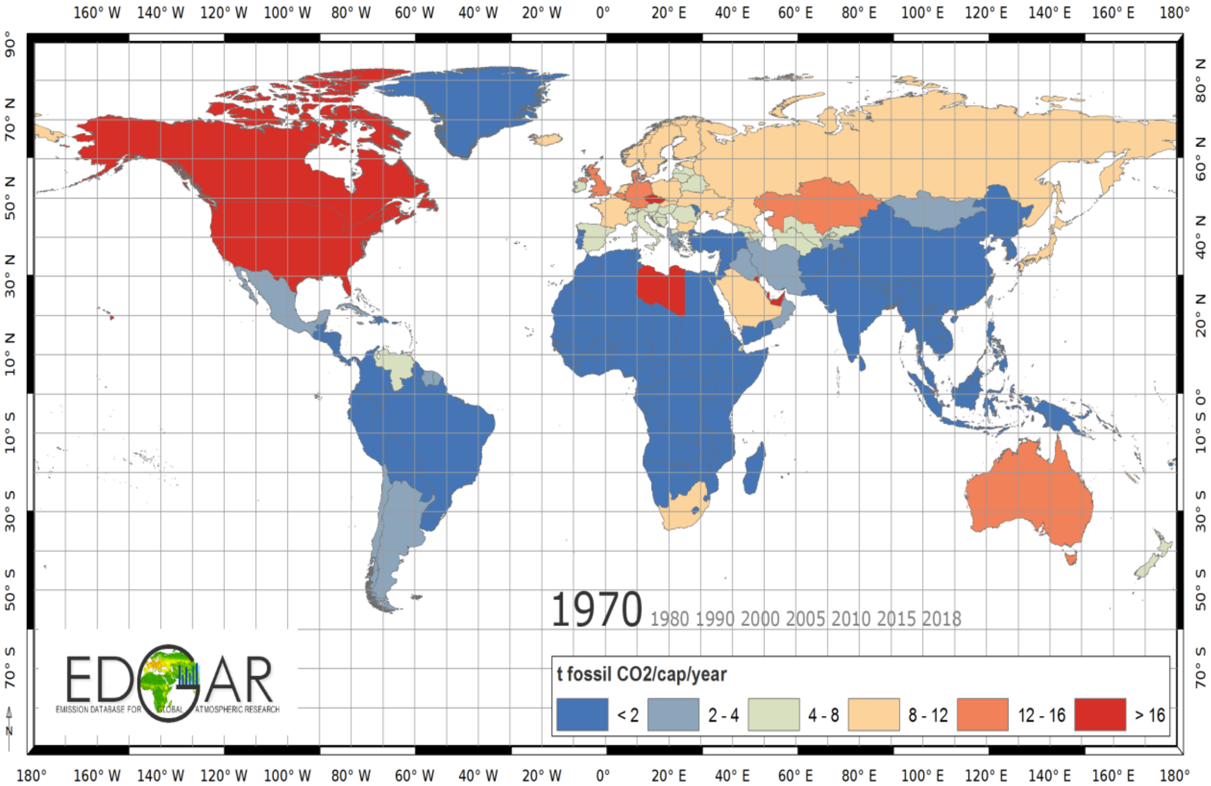
Introduction

Global climate change



(Mcleod *et al*., 2020)

Global carbon emission

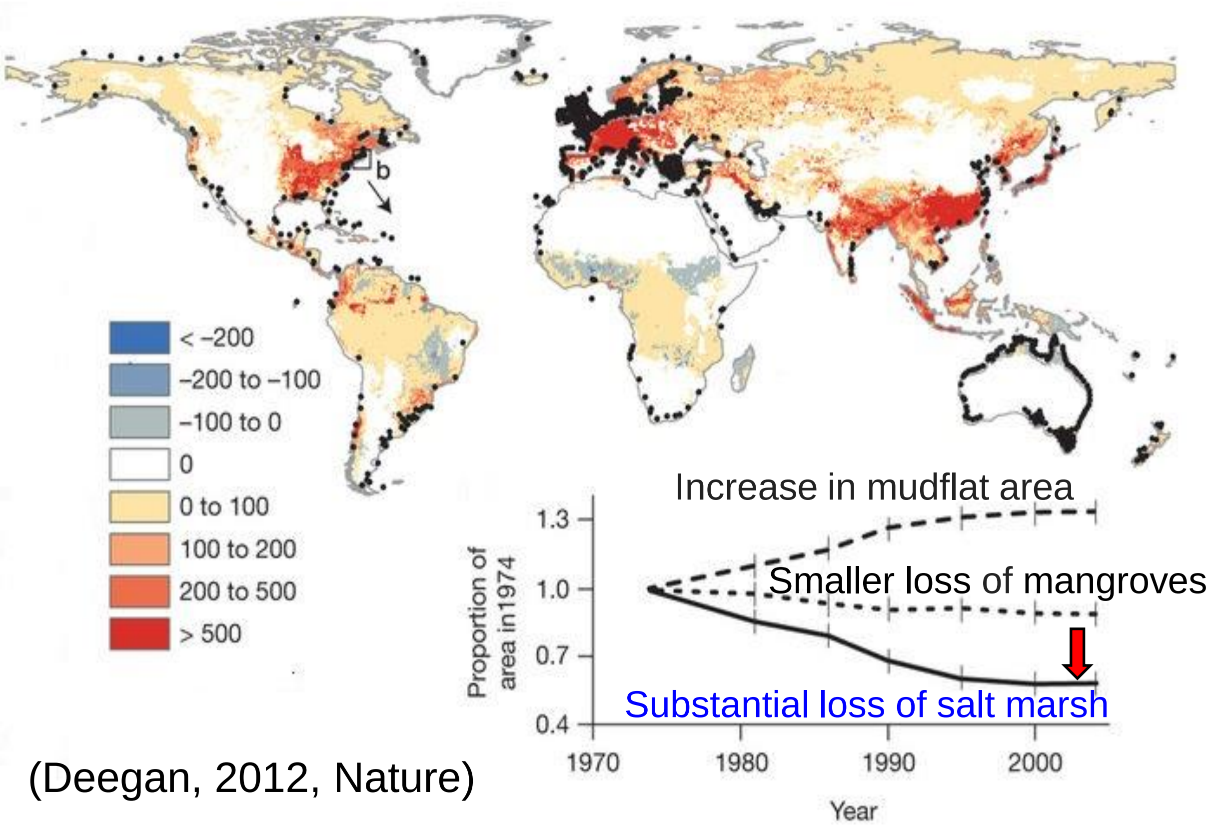


(Crippa *et al*., 2020, Publications Office of the EU)

- Progressive land-use changes, deforestation, and excessive combustion of fossil fuels have increased greenhouse gas emissions.
- To address this issue, the IPCC appealed for greenhouse gas mitigation strategies.

Introduction

Blue carbon ecosystem



(Deegan, 2012, Nature)

Degradation of coastal soils

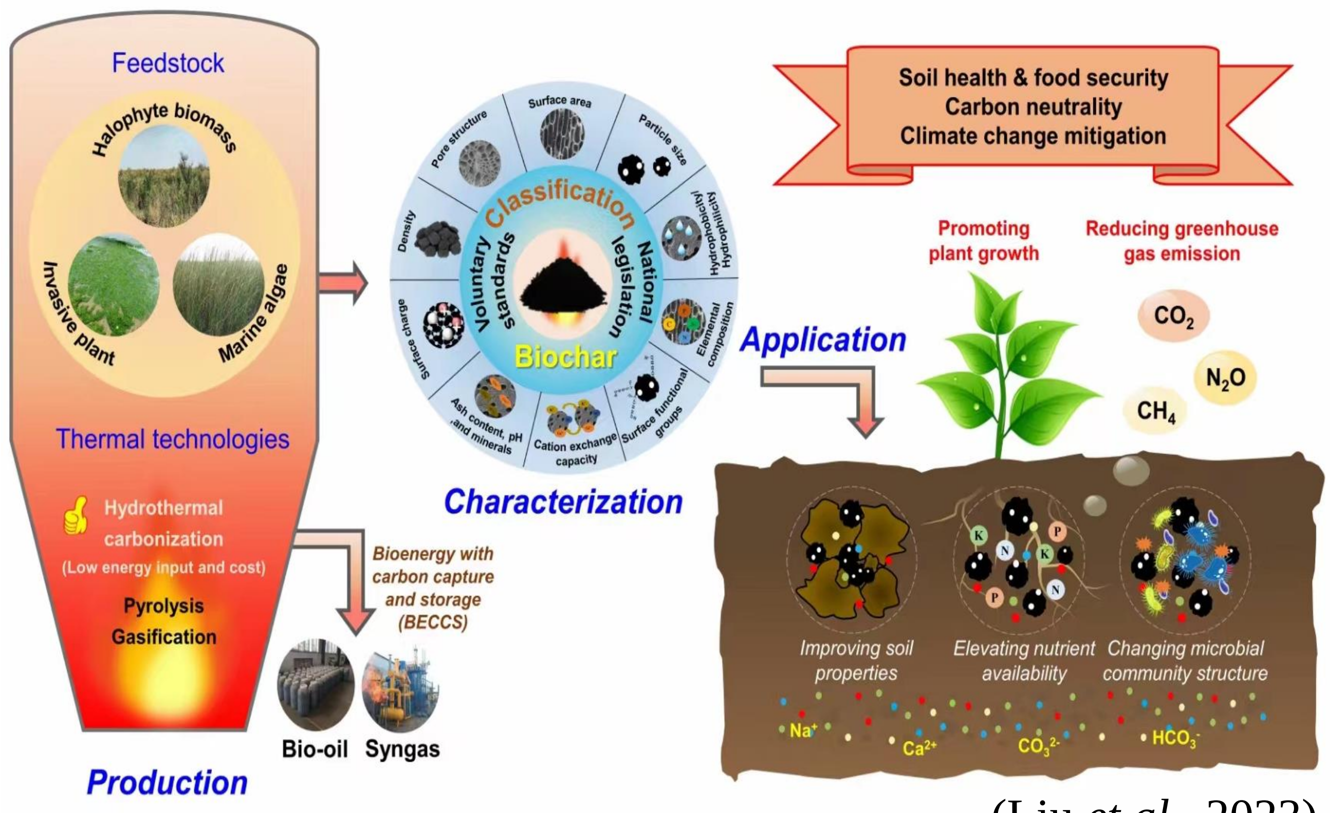
- **Salinization:** 0.4–3%， pH 8–9.5
- **Low C sequestration:** 5–10 g/kg
- **Low nutrient availability:** P 4.68~20.8 mg/kg； N 4.68~20.8 mg/kg
- **Poor structure：** Poor ventilation and water permeability

（Huang *et al.*, 2012; Wu *et al.*, 2014）

- Coastal salt-affected soils hold a great potential for climate change mitigation and carbon sequestration.
- Acting as significant natural C sinks, coastal wetlands play important roles in the global C cycling.
- Degraded coastal soils caused 0.15–1.02 Pg (billion tons) of CO_2 released annually.

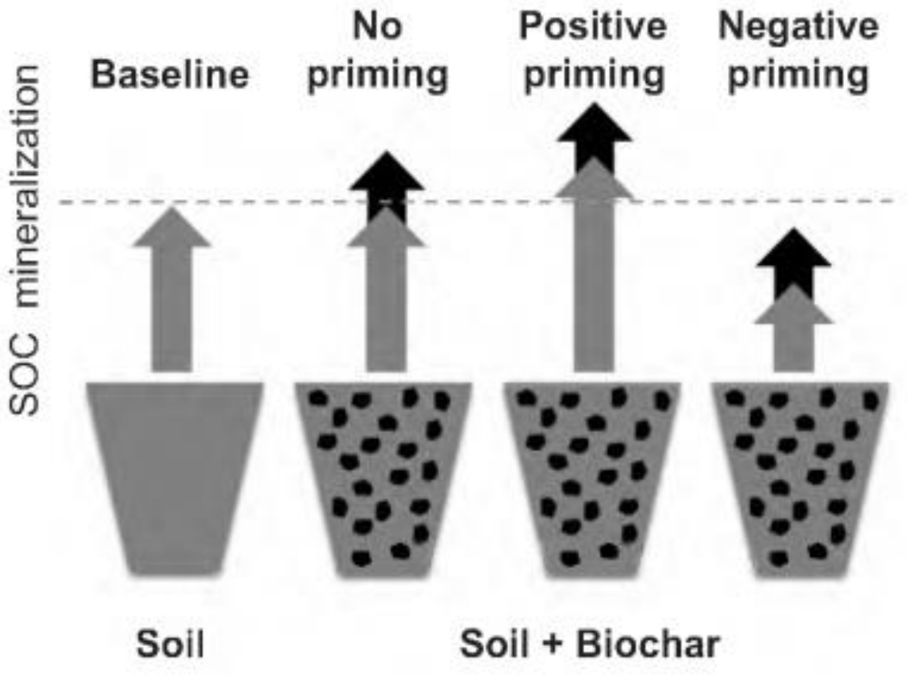
Introduction

Soil carbon sequestration materials



(Liu *et al.*, 2023)

Priming effect on SOC decomposition

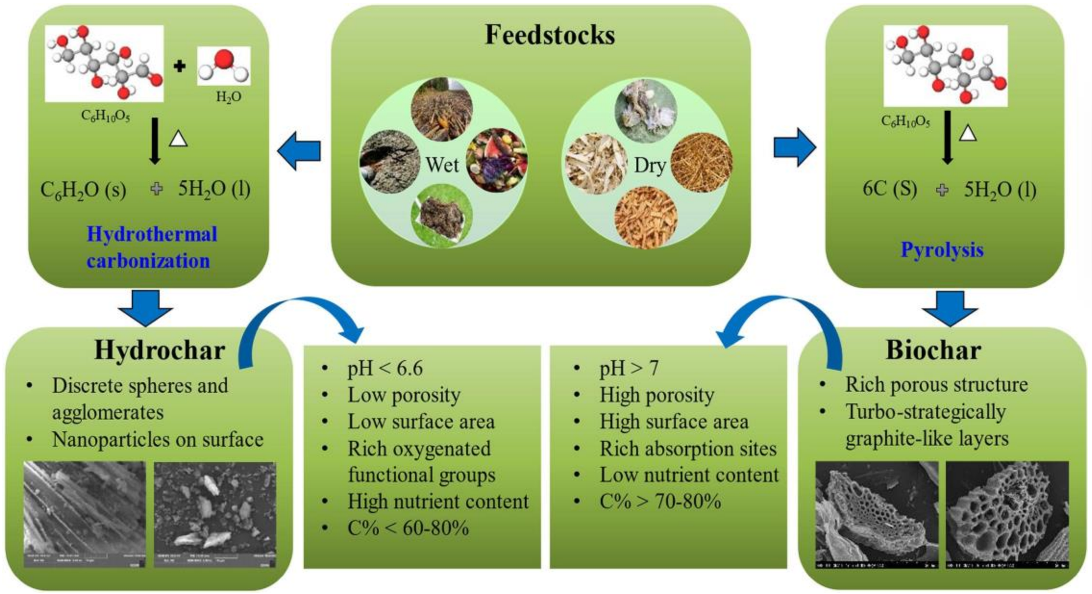


(Whitman *et al.*, 2014)

- Char amendment (e.g., pyrochar and hydrochar) as a soil C sequestration material has gained considerable attention for CO_2 emission mitigation.
- Char amendment can increase, decrease, or have no effect on soil organic carbon (SOC) decomposition, corresponding to positive, negative, and no priming effect.

Scientific question

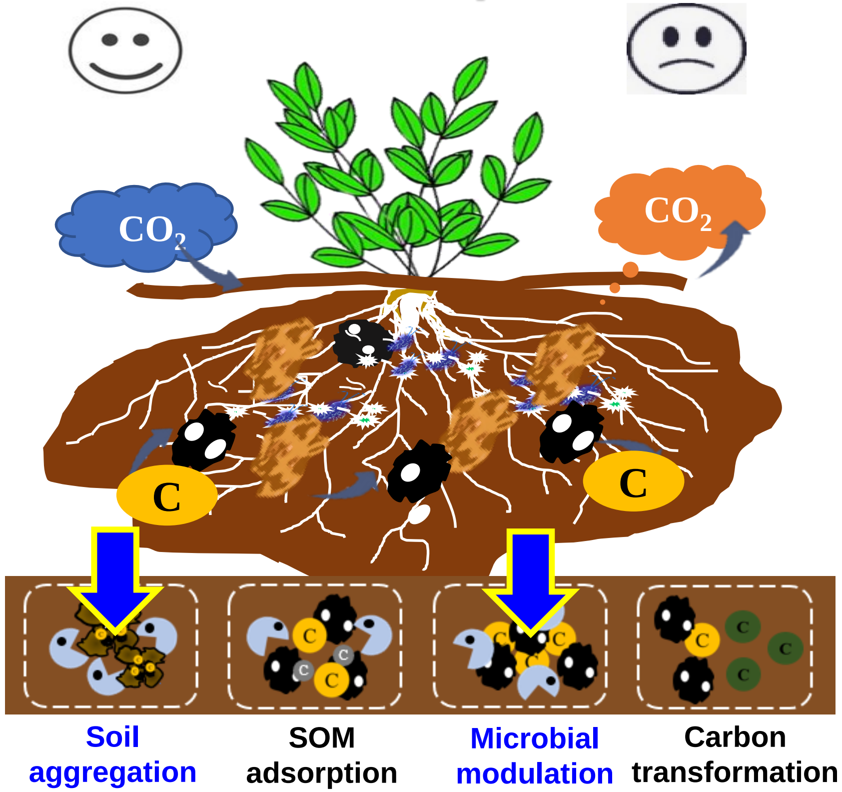
Hydrochar vs Pyrochar



(Khosravi *et al.*, 2022)

- However, most studies have focused on pyrochar effects on CO_2 emission of non-salt-affected soil, limited attention has been paid to the effects of hydrochars on coastal salt-affected soils.
- The mechanisms of hydrochar-mediated soil aggregation and microbial responses for SOC decomposition in the coastal salt-affected soils were poorly understood.

SOC decomposition



(Liu *et al.*, 2023)

Acid soils

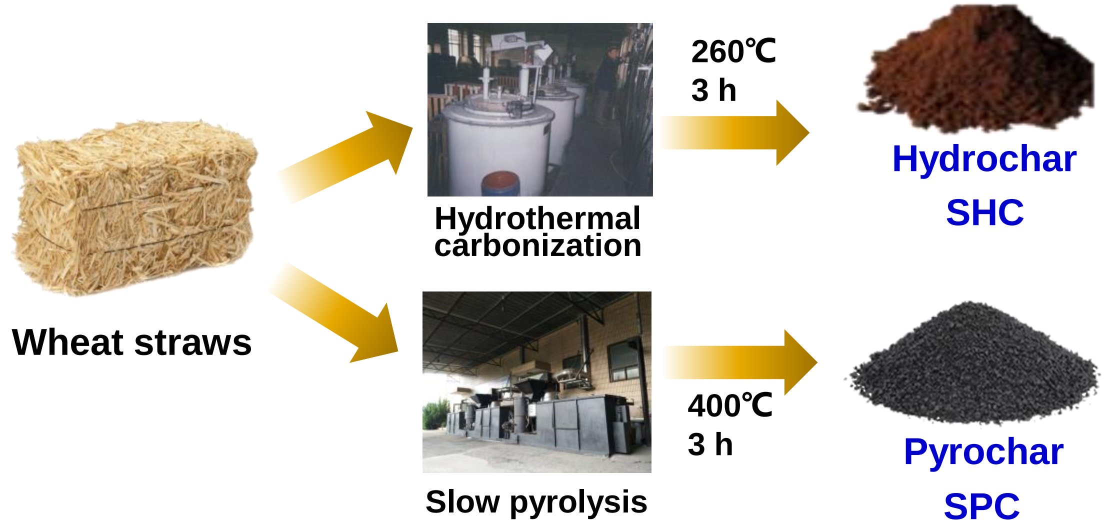
Neutral soils

Coastal salt-affected soils

?

Experiment design

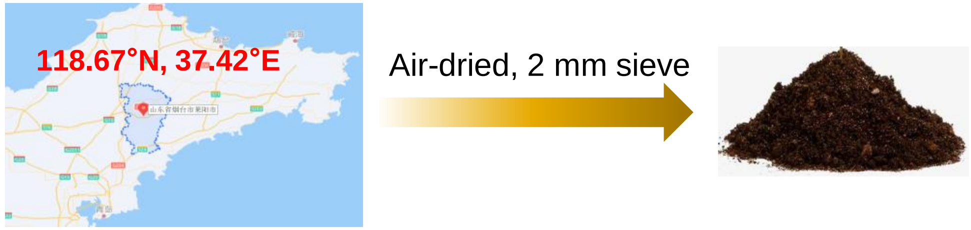
➢ Preparation of hydrochar and pyrochar



➢ Soil microcosm experiment

➢ Soils

Coastal salt-affected soils in Yellow river delta



➢ Soil sample analysis

■ Soil aggregate analysis

✓ Macroaggregate（250–2000 μm）
Microaggregate（53–250 μm）
Silt-clay fraction（< 53 μm）

✓ Mean weight diameter（MWD）

Wet-sieving

■ Soil DOM analysis

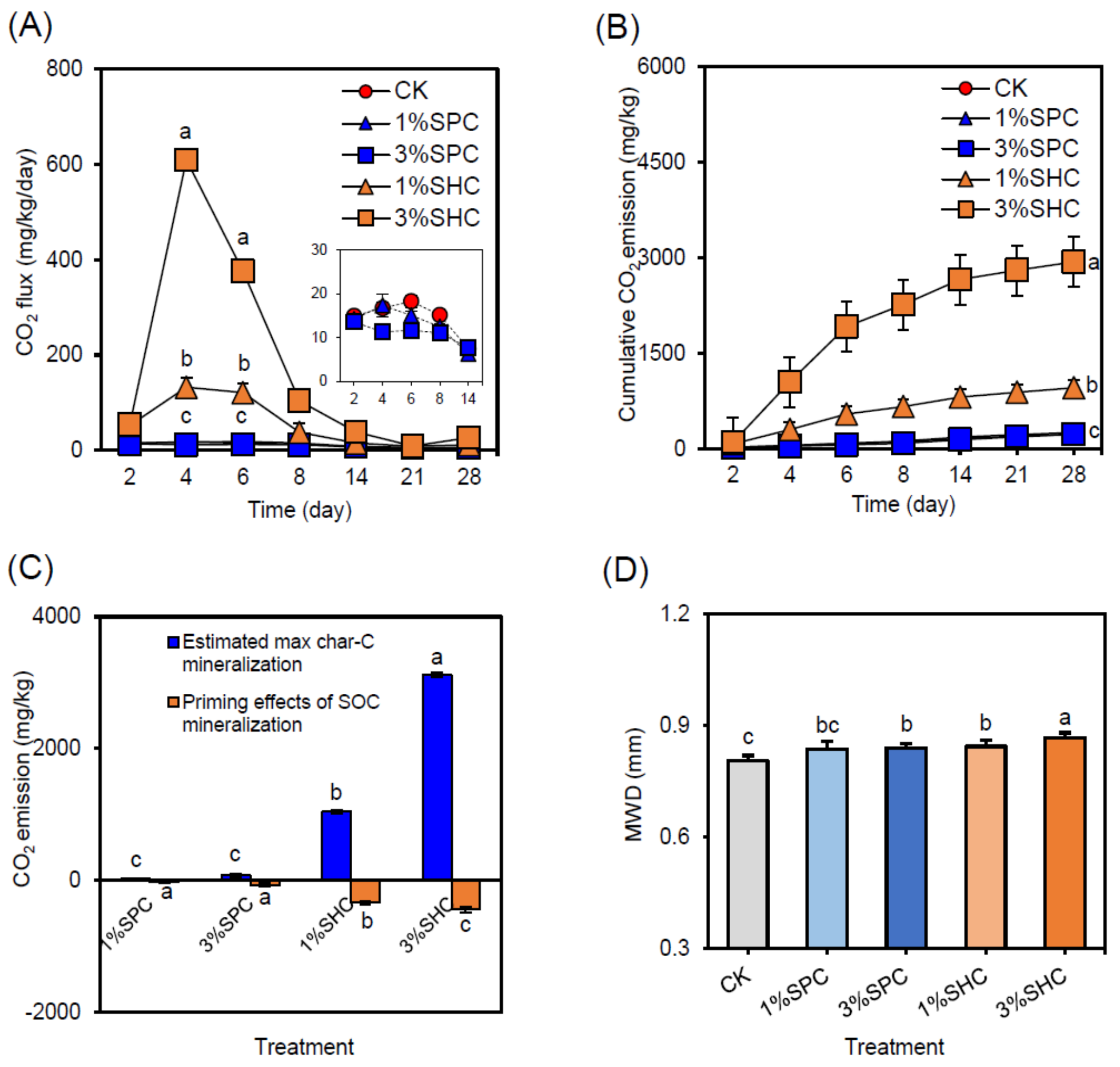
✓ DOM components: fulvic-acid substrates, humic acid-like substances, microbial metabolic protein

■ Soil microbial community analysis

✓ 16S rRNA MiSeq sequencing

Results

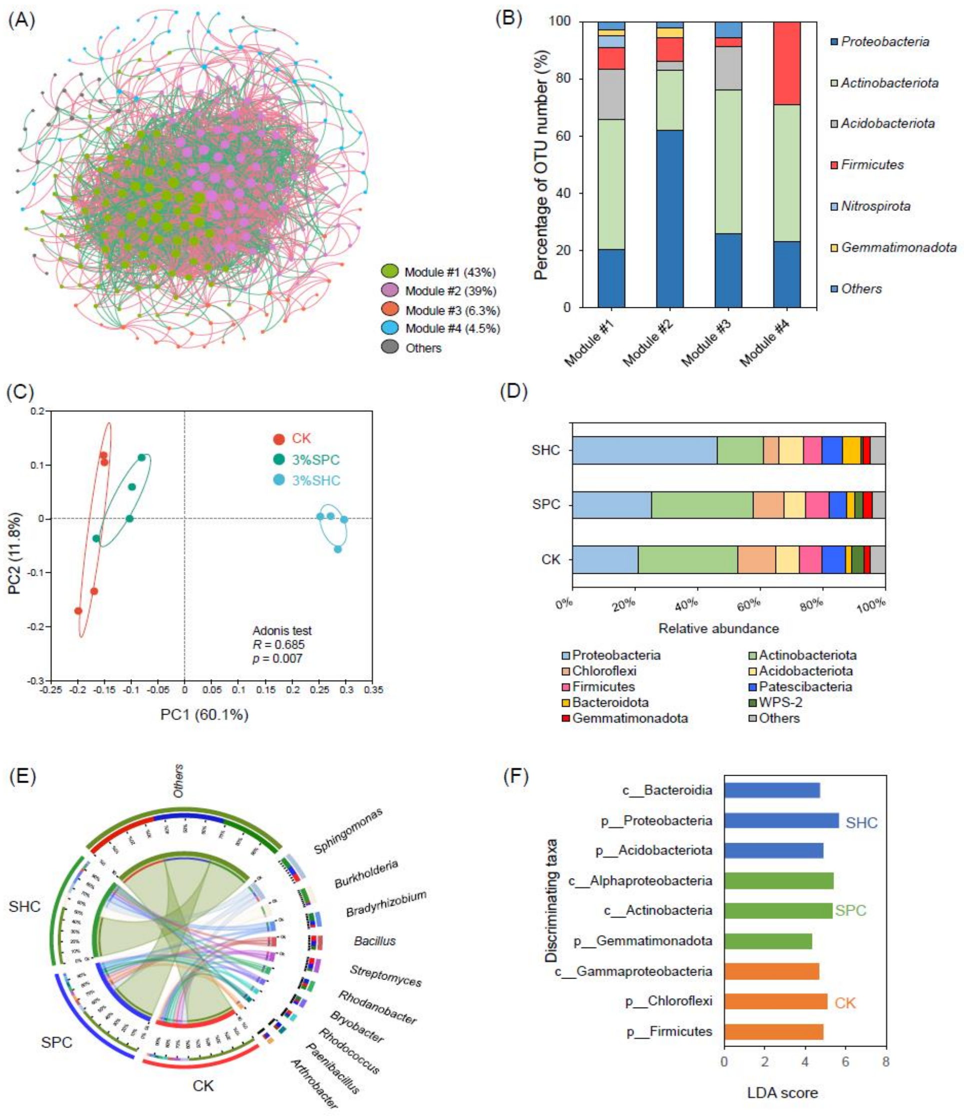
➢ Char-induced negative priming effect of SOC decomposition



- SHC amendments markedly increased soil CO_2 flux relative to CK, with order of SHC at 3% > SHC at 1% (w/w), but SPC amendments had little effect.
- The net priming effects on SOC decomposition can be evaluated by subtracting char-DOC from total CO_2 emission.
- SHC and SPC amendments induced the negative priming effect correspondingly up to 337-440 mg/kg and 29.2-73.7 mg/kg.
- SHC posed the greater promotional effects on soil aggregation than SPC.

Results

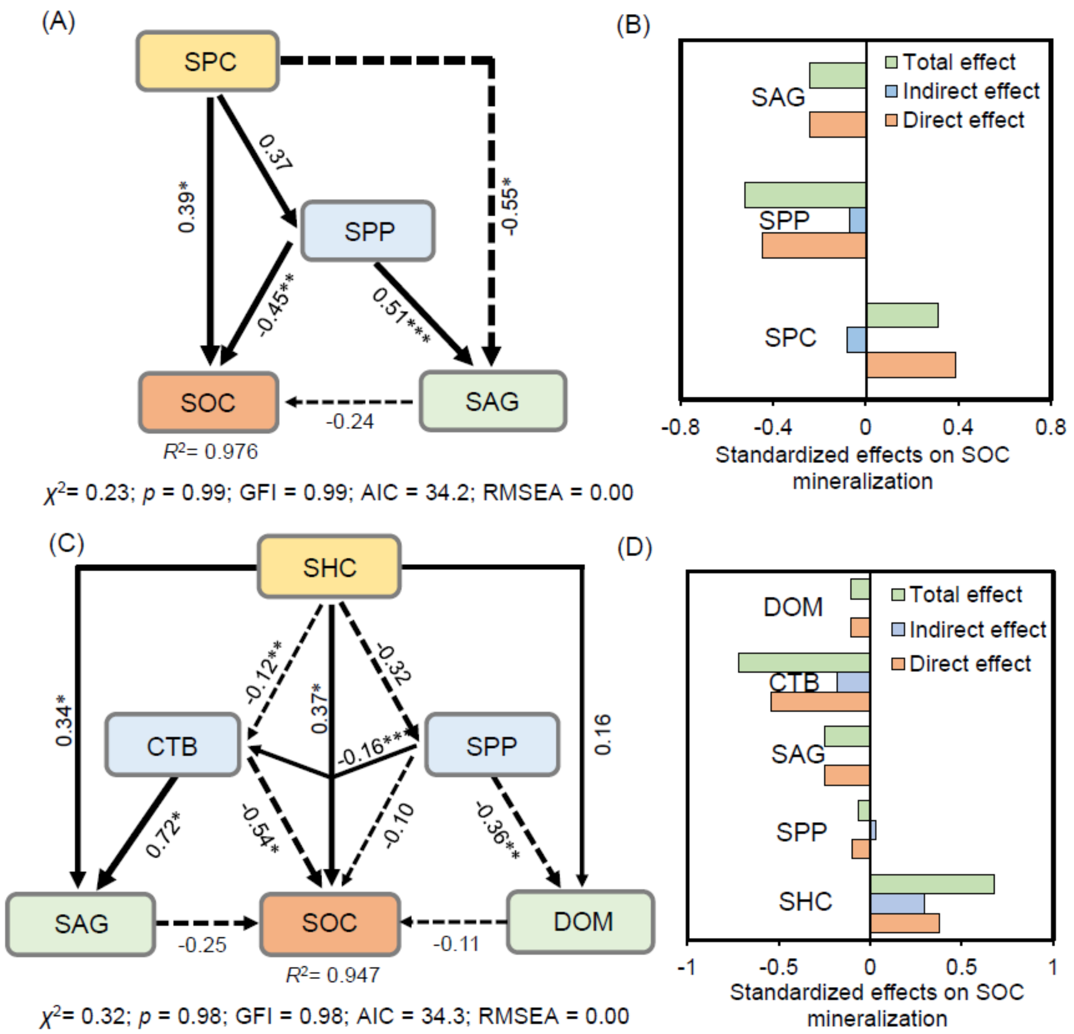
➢ Char-altered response of bacterial community composition



- ➢ SHC increased the Simpson index, exhibiting the lifted bacterial community diversity.
- ➢ SHC treatment remarkably altered the composition of soil bacterial community by PCA analysis.
- ➢ SHC increased the relative abundance of bacterial taxa participated in soil aggregation and polysaccharide-C degradation.
- ➢ SHC triggered transformation of microbial function potential, which could potentially promote soil humification and aggregation-mediated soil SOC stabilization.

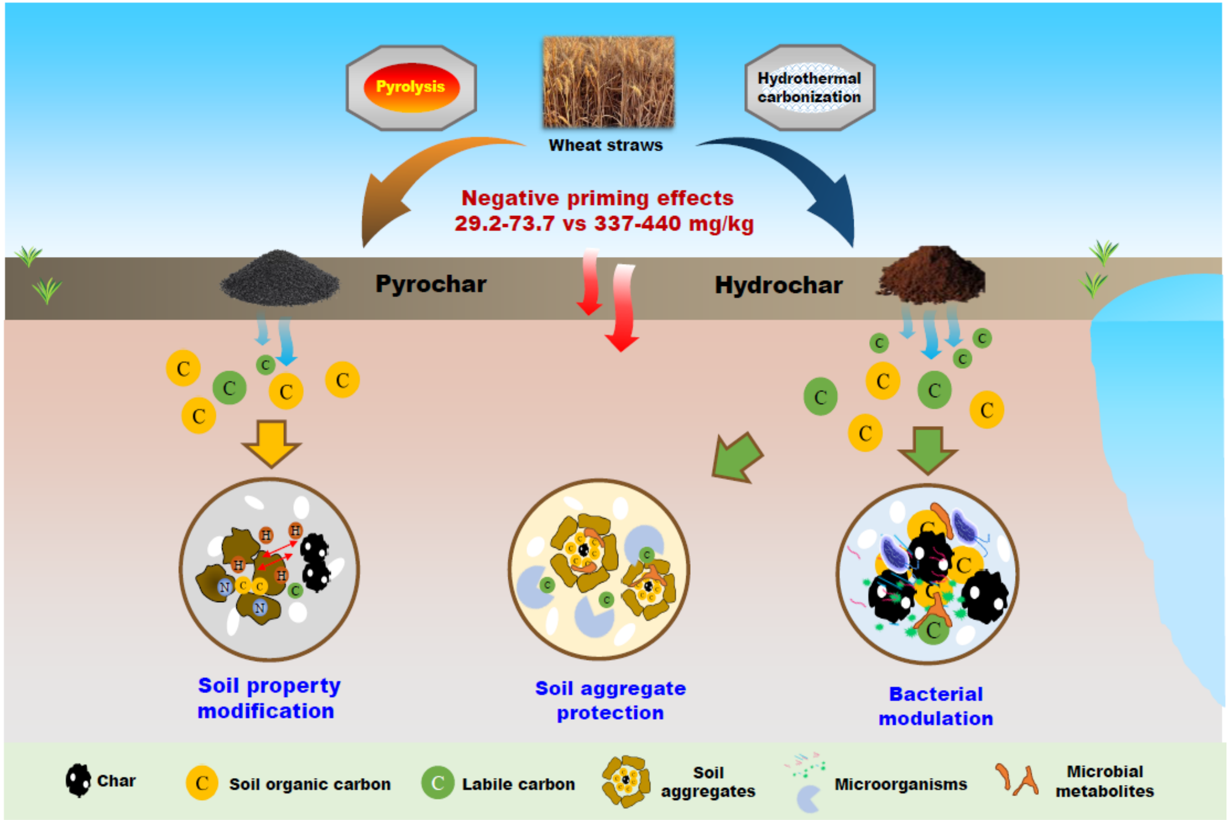
Results

➢ Distinguished key factors for char-affected SOC decomposition



- ➢ SEM analysis revealed the contributions of influential factors to char-induced alterations in SOC decomposition.
- ➢ Modification soil properties by SPC (decreased soil pH and increased C/N ratios) were the greatest contributors to negative priming effects.
- ➢ Comparatively, the bacterial modulation of soil C transformation induced by SHC predominantly contributed to negative priming effects, with secondary effects including enhanced soil aggregation and altered DOM composition.

Summary



Our study revealed that SHC induced a more significant negative priming effect on SOC decomposition compared with SPC. These findings provide novel insights into the potential roles of hydrochar in shaping the C cycle dynamics of salt-affected soils. Furthermore, they lay the groundwork for enhancing the carbon sequestration potential of these blue carbon ecosystems.

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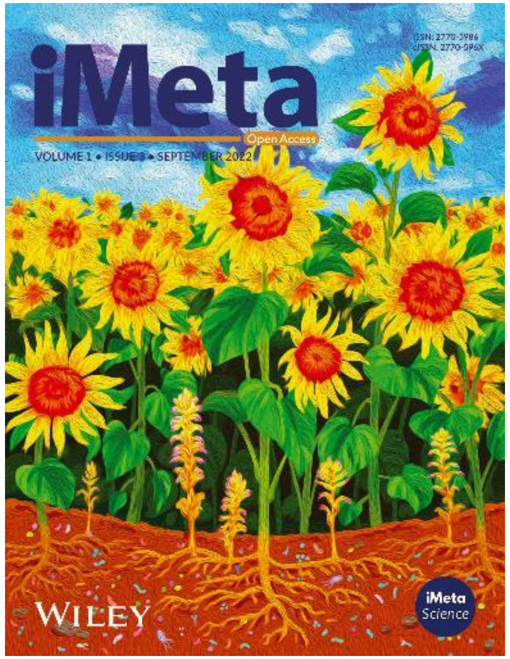

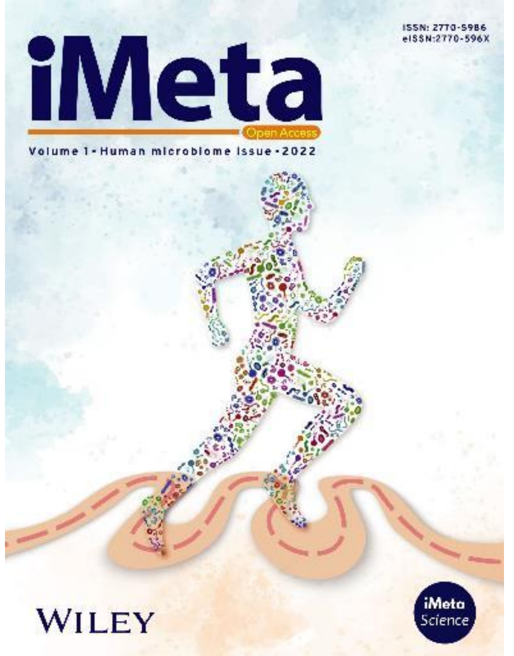

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