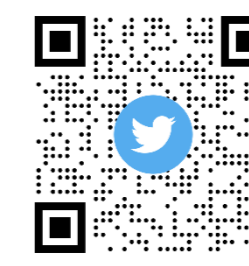


# Gradual recovery of soil structure and organic carbon stocks in semi-arid fine-textured soils after setting aside arable land

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## 1. Introduction

The **set-aside** practice is traditionally applied in the Mediterranean region to restore soil fertility from intensive cultivation. However, the efficacy of set-aside in **recovering soil structure** and **soil organic matter** in semi-arid agroecosystems remains unclear. In this study, we estimate the **timescales** required for a degraded soil to reach **soil fertility thresholds** levels under set-aside.

## 2. Study Design and Region

We studied **three adjacent fields** subjected to set-aside for **different periods of time**. Until 1964, the three fields comprised an **arable cropland** under **uniform management**. In 1964, the cropland **converted to a vineyard** tilled twice per year, while a part was converted to **set-aside**. In 2008, another part of the field was also converted to set-aside.

The three fields were located in Heraklion, Crete (MAP =654 mm, MAT =17.3°C). The soil had a fine texture (silt =36%, clay =53%) and a pH of 8.1. In Spring 2014, soil samples were collected at 0-15 cm.

### Space for Time Substitution



Active Vineyard  
50 y under tillage



Set-aside Field  
50 y unmanaged

**Fig 1.** Photos of the active vineyard receiving tillage twice per year the last 50 years (left) and of the set-aside field that is unmanaged for 50 years (right). We assumed that if the active vineyard would be converted to set-aside „now“, it would resemble the fields under 6 and 50 years of set-aside with the passage of respective time periods.

## 3. Data and Modeling

We isolated **soil aggregates** with wet sieving, determined **soil organic carbon (SOC)** and, using soil bulk density, we calculated **SOC stocks**.

With the **Carbon, Aggregation and Structure Turnover (CAST)** model, we simulate the sequence of set-aside fields. The vineyard field (1964-2014) was used as the **starting point** of the simulation. Based on the Space for Time Substitution (Fig. 1) the two fields under set-aside were used as **calibration points** (Fig. 2).

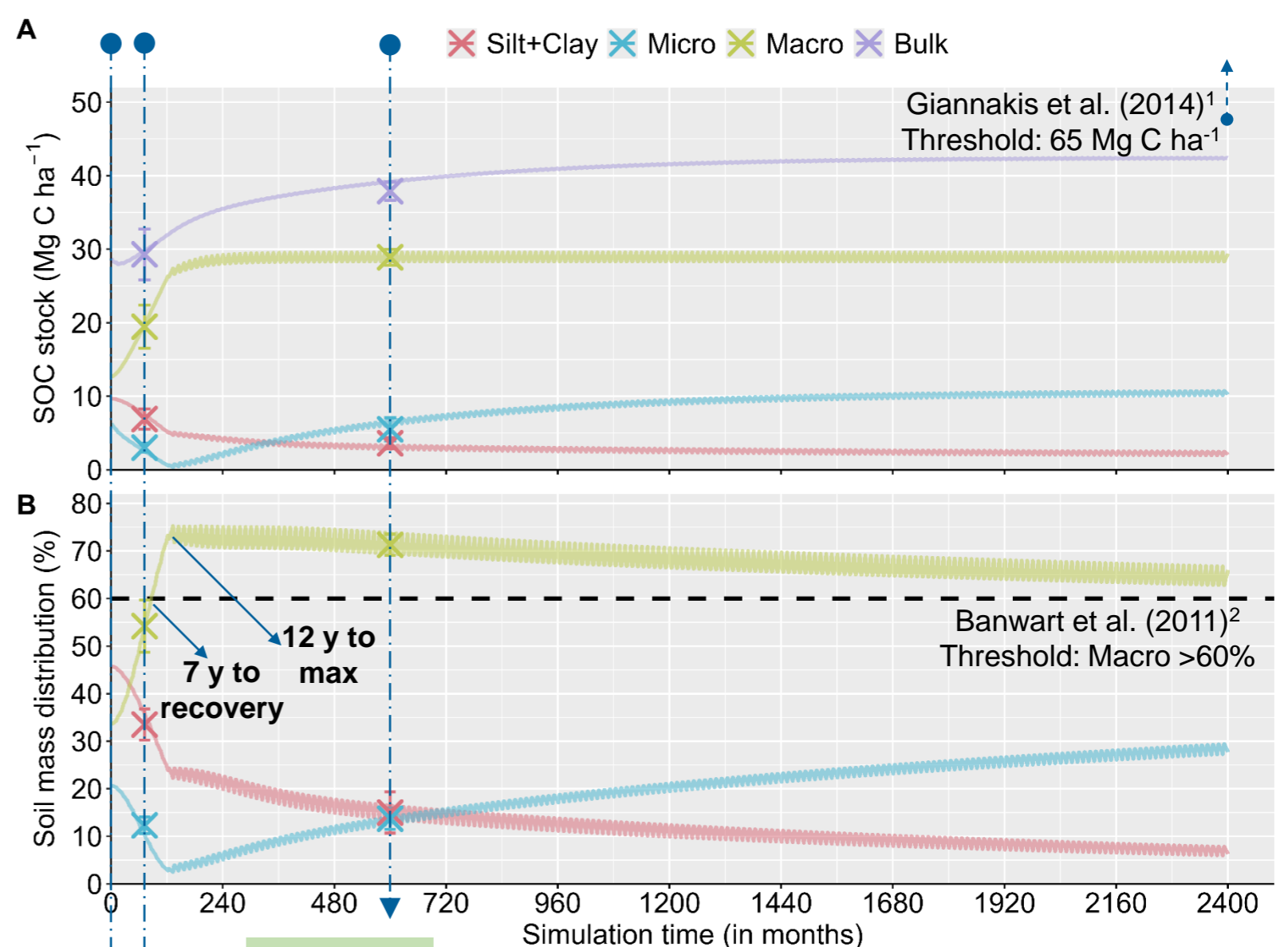
## Conclusions

The **CAST** model **successfully simulated** soil structure and SOC under set-aside in a fine-textured soil of a semi-arid region.

**Soil structure** required **seven years** to recover, while **SOC did not reach fertility thresholds** even after 200 simulation years.

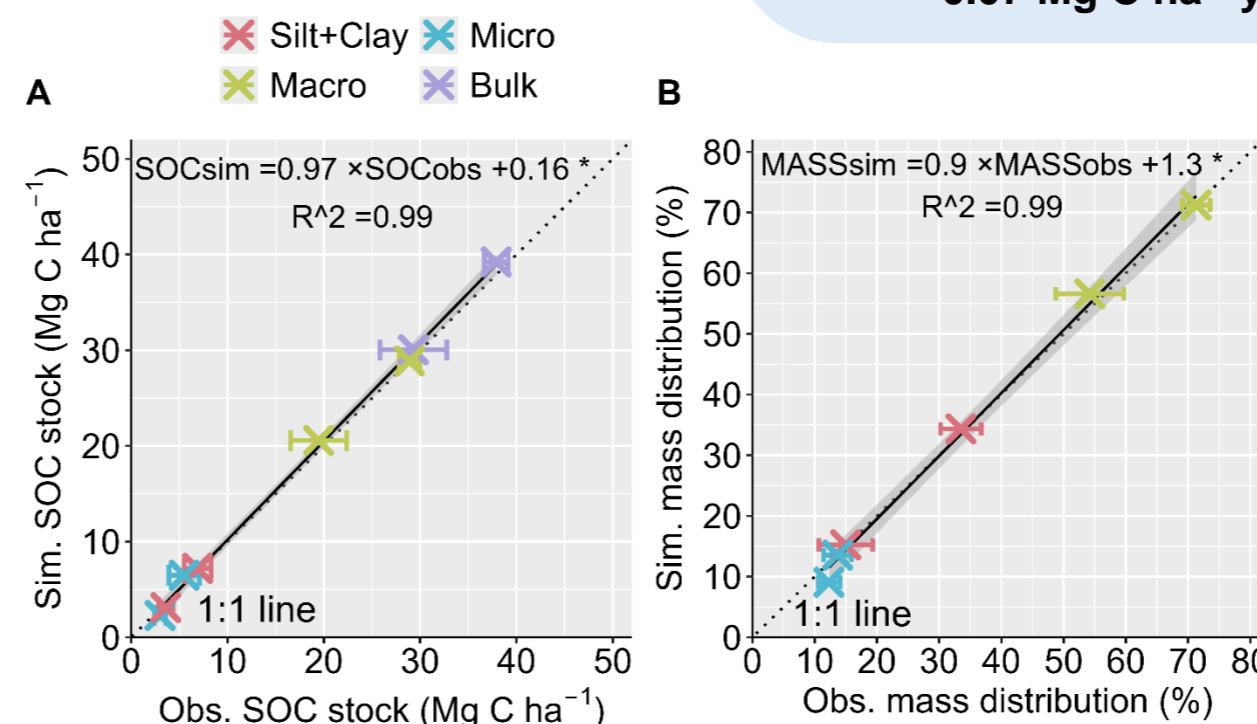
**Set-Aside Does Not Suffice** for the restoration of degraded agroecosystems in productivity-limited semi-arid regions !

Combining **Set-Aside** with **Soil Amendments** (i.e., increasing carbon inputs) might **speed up** the recovery process and increase the **agroecological feasibility** of the practice.



**Fig 3.** Soil aggregate mass distribution and SOC stocks simulation for the conversion of an active vineyard to set-aside for 200 simulation years. Lines and points show simulation and observed data respectively.

**Sequestration rates**  
**4% Initiative down to 2 m:**  
**0.64 Mg C ha<sup>-1</sup> y<sup>-1</sup>**  
**Set-Aside 20 y down to 15 cm:**  
**0.34 Mg C ha<sup>-1</sup> y<sup>-1</sup>**  
**Rest 180 y down to 15 cm:**  
**0.07 Mg C ha<sup>-1</sup> y<sup>-1</sup>**



**Fig 2.** Simulated vs. Observed soil organic carbon stocks (A) and (B) soil aggregate mass distribution for the field under set-aside for 6 y and the field under set-aside for 50 y.