# Modelling forest soil organic carbon dynamics with Biome-BGCMuSo model

## INTRODUCTION

**Soil organic carbon** (**SOC**) is the largest terrestrial C pool and a mandatory C pool in GHG inventory. Due to ongoing impacts of climate change, alterations in SOC are expected, hence monitoring of this C pool is relevant. To be able to accurately predict SOC, model results need to be verified with field data.

Is **Biome-BGCMuSo** model applicable for estimating C stock changes in the forest $SOC_{30}$?

## METHODS

**BIOME-BGCMuSo MODEL**
(Hidy *et al.* 2012, 2016, 2022)
Terrestrial biogeochemical model that simulates C, N and $H_2O$ fluxes in ecosystems.

- RBBGCMuso (Hollós *et al.* 2023)

Calibrated with data on C stocks and C fluxes (v6.2):
forest (oak, *Quercus robur*) – HR (Bitunjac 2024)

**Validation dataset**

**OAK CHRONOSEQUENCE EXPERIMENT**

Six stands aged from 6 to 139 years
(Fig. 1, 2, Ostrogović Sever *et al.* 2019)

- **Repeated $SOC_{30}$** (2012, 2017, 2022)

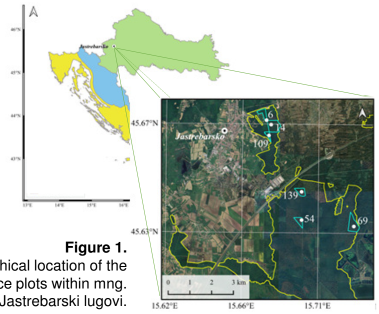


**Figure 1.** Geographical location of the chronosequence plots within mng. unit Jastrebarski lugovi.


**Figure 2.** Chronosequence stands (ID, in black) and different ages (in blue and in parenthesis).

## SOC MODELLING

Measured *vs.* modelled $SOC_{30}$ changes

Short-term (2012 – 2022)

Long-term (the rotation period for *Q. robur* stand in Croatia)

## RESULTS

### Period 2012 – 2022

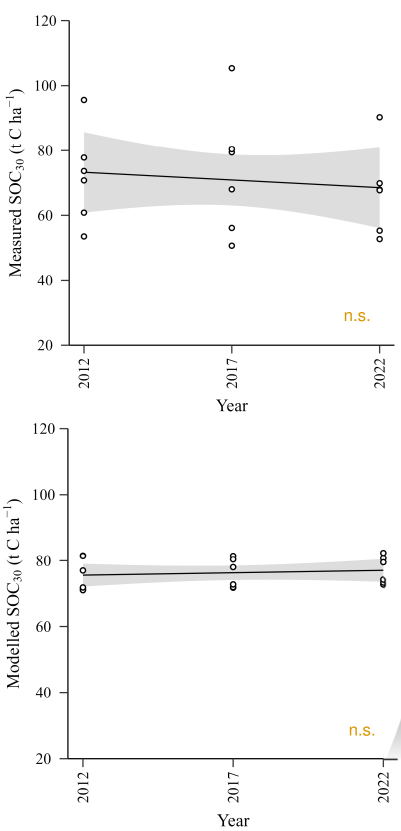


**Figure 3.** Measured and modelled soil organic carbon in the mineral soil layer down to 30 cm depth ($SOC_{30}$) in the pedunculate oak forest (including six chronosequence stands, white filled circles) during a ten-year period with grey shading denoting 95% confidence intervals.

The lack of statistically significant trend in the measured $SOC_{30}$ restricts statistical inference regarding the modelled $SOC_{30}$.

Longer time series and higher sampling density is required!

### Long-term

Only in repeated chronosequence approach age trend in measured $SOC_{30}$ is observed!

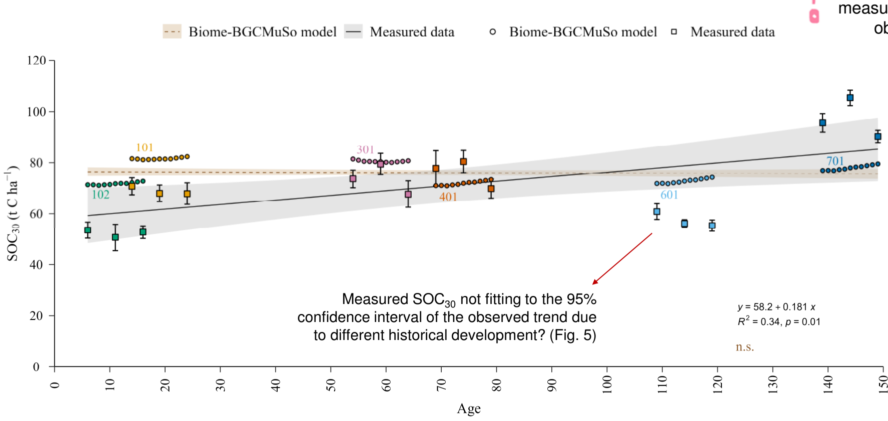


**Figure 4.** Comparison of the measured (squares, mean ± se; solid trendline with grey shading denoting 95% confidence intervals) and modelled (circles; dashed trendline with light-yellow shading denoting 95% confidence intervals) $SOC_{30}$ for different stands in the chronosequence experiment (102, 101, 301, 401, 601, 701) and at different stand ages. Data points represent the year of the measurement for each stand; measured data years are 2012, 2017, and 2022, from left to right, and for modelled data, measured years range from 2012 to 2022, from left to right.

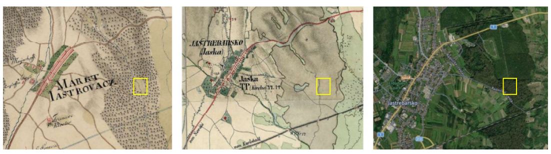

**Figure 5.** The approximate location of the stand 601 (in yellow rectangle) in the period 1783–1784 (non-forest land, Molnár *et al.* 2014) (left panel), period 1865–1869 (forest land, Timár *et al.* 2006) (middle panel) and in the year 2024 (forest land, right panel).

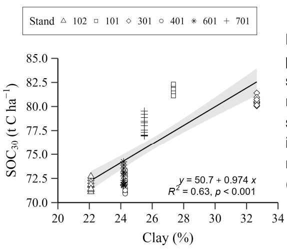


**Figure 6.** Linear regressions of pedunculate oak chronosequence stand-specific clay in the soil on modelled $SOC_{30}$, with grey shading denoting 95% confidence intervals. Data points in the forest represent data modelled years (2012 – 2022) (N = 10).

There are indications that the soil clay content is a stronger driver of modelled $SOC_{30}$ than the stand age.


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