

# Application of Biome-BGCMuSo model at the country-scale of Croatia and Slovakia

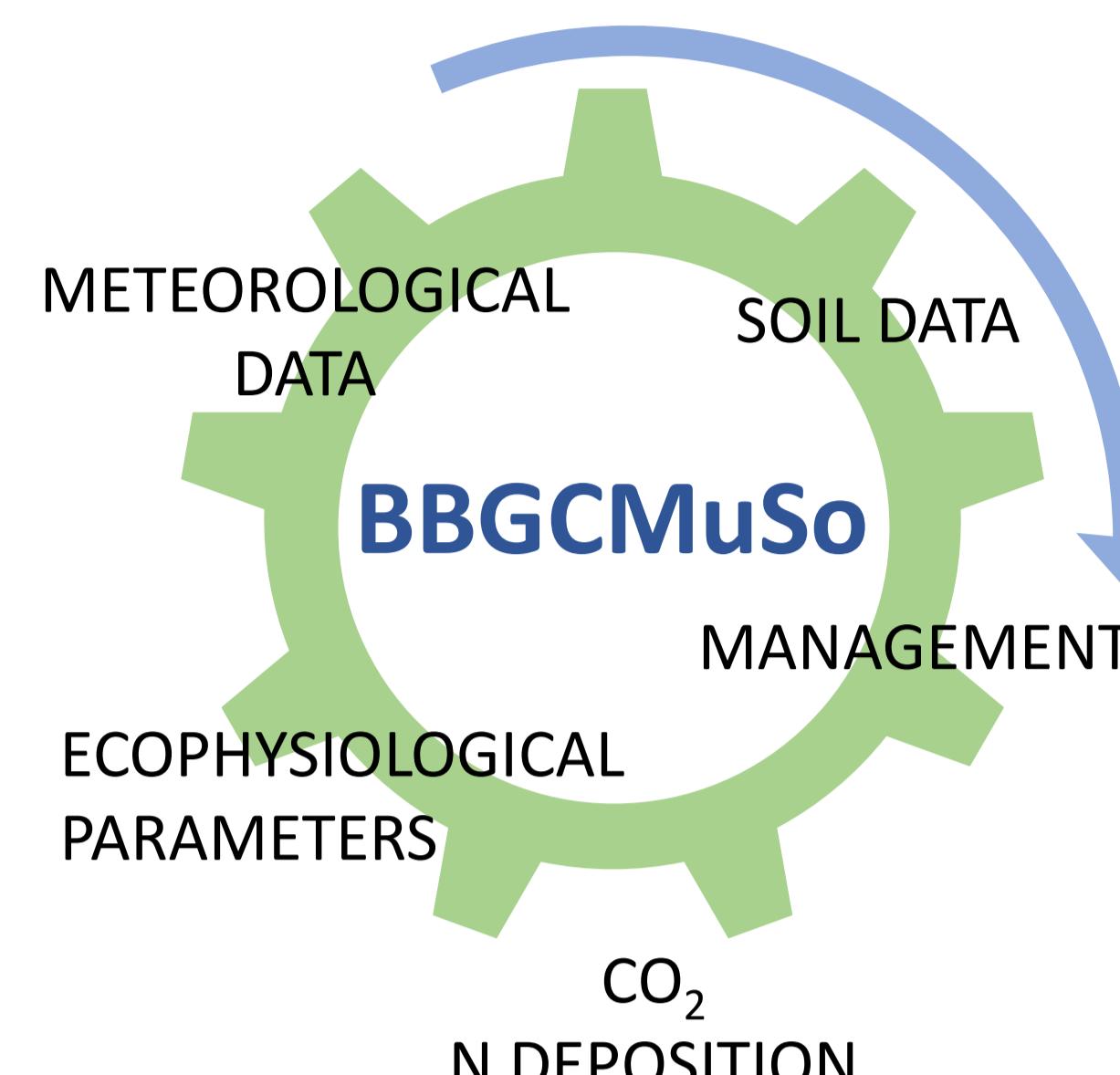
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## Aim

To test Biome-BGCMuSo (BBGCMuSo) model (ver 6.2) capability for facilitating national GHG inventory reporting.

**01)** to validate the model for forest C stocks at the country-scale, and

**02)** to provide country-specific C stock change (CSC) factors for deadwood (DW), litter (LIT) and soil (SOC) under *Forest land* remaining *Forest land* subcategory of the LULUCF sector.



## Model and data

Biome-BGCMuSo (<https://nimbus.elte.hu/bbgc/>) is a process-based stand-level biogeochemical model that simulates stocks and fluxes of carbon (C), nitrogen (N) and water (H<sub>2</sub>O).

**Meteorological data** -> daily ERA5-Land meteorological dataset (ISIMIP3a protocol, <https://protocol.isimip.org/#/ISIMIP3a>, Frieler et al. 2024), 1951-2023

**Eco-physiological parameters** -> species-specific values of eco-physiological parameters from published literature (Merganičová et al. 2024)

**Soil data** -> site-specific soil texture & pH from national databases

**Management** -> country-specific BAU practices (thinning rates & intensity, rotation periods)

**CO<sub>2</sub>, N deposition** -> annual data following ISIMIP3a protocol, 1850-2023

» BIOME-BGCMUSO CAN RELIABLY REPRODUCE ABOVEGROUND WOOD C STOCKS AT THE COUNTRY SCALE IN BOTH CASE STUDIES«

» MODELLED CSC FACTORS FOR DW, LITTER AND SOC CAN HELP MEET THE COMPLETNESS PRINCIPLE OF GHG INVENTORY REPORT «

## STUDY LIMITATIONS & CHALLENGES

- Stratification and simulation of representative forests may cause unrealistic interannual variations and/or deviations at a country level
- Impact of conversion factors (biomass expansion factors, basic wood density, C fraction) on modelled GS in validation
- Temporal changes in species composition, age class distribution due to management and/or disturbances should be considered for upscaling

Results of strata simulations of live biomass (LB), deadwood (DW), litter (LIT) and soil (SOC) were upscaled using land x forest strata proportions (Figure 1) for the period 1990-2023 to country scale (Figure 3).

**Application**  
 Slopes of linear regressions of modelled C stocks in LB, DW, LIT and SOC were compared with currently used CSC factors in country-specific Common Reporting Tables (CRT) (Table 1).

## Methods

### Land stratification

- climatic zones (HR) or geobiotopes (SK)
- soil texture: clay (>30% clay), loam (<30% clay)
- soil depth (HR): shallow (<=1m), deep (>1m)

### Forest stratification

- Tree species and stand structure (OAKS, BEECH, PINES, FIR, SPRUCE, COPPISE)
- Management type (even-aged, uneven-aged, protected)
- Age classes (for even-aged)

**Model simulations** were performed for each land x forest stratum, in total 306 in HR and 308 in SK.

### Validation

Comparing strata-specific modelled aboveground woody C (AGCw) to measured growing stock (GS), in the years 2022 (HR) and 2023 (SK) using country-specific conversion factors (Figure 2).

### Upscaling

Results of strata simulations of live biomass (LB), deadwood (DW), litter (LIT) and soil (SOC) were upscaled using land x forest strata proportions (Figure 1) for the period 1990-2023 to country scale (Figure 3).

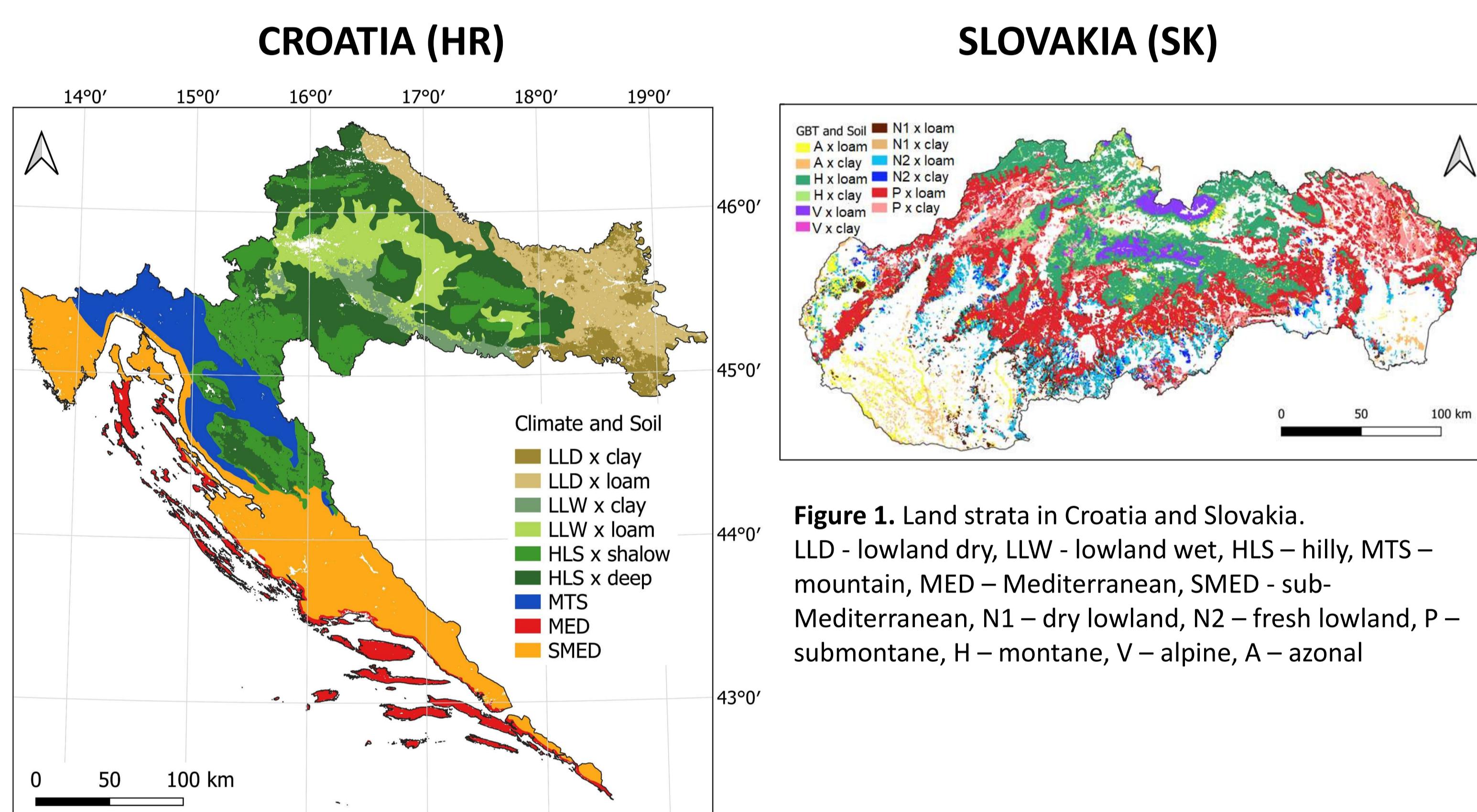


Figure 1. Land strata in Croatia and Slovakia. LLD - lowland dry, LLW - lowland wet, HLS - hilly, MTS - mountain, MED - Mediterranean, SMED - sub-Mediterranean, N1 - dry lowland, N2 - fresh lowland, P - submontane, H - montane, V - alpine, A - azonal

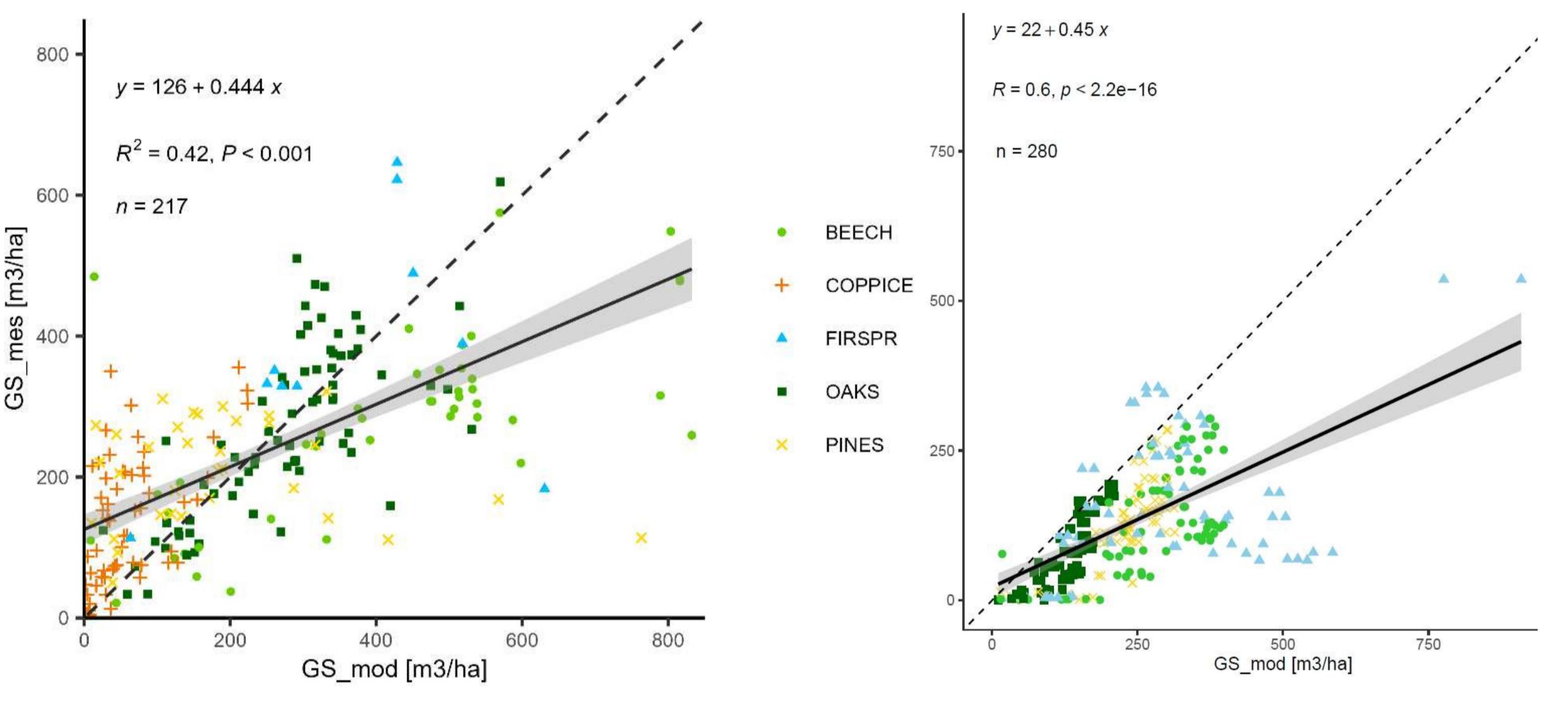


Figure 2. Strata-wise comparison of modelled and measured growing stock (GS) in Croatia (left panel) and Slovakia (right panel).

Sources for conversion factors used in HR are Wirth et al. (2004) for BEF, and Bitunjac et al. (2023) for BWD & CF, and in SK is Slovakia NID (2024) at <https://unfccc.int/documents/644823> for BEF, BWD & CF.

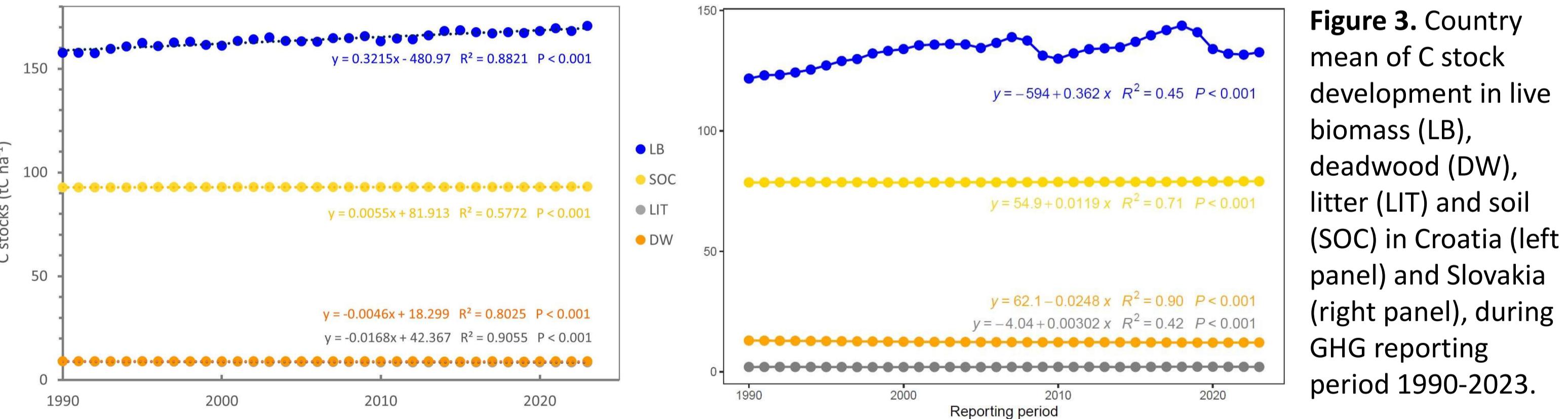


Figure 3. Country mean of C stock development in live biomass (LB), deadwood (DW), litter (LIT) and soil (SOC) in Croatia (left panel) and Slovakia (right panel), during GHG reporting period 1990-2023.

| Country  | Total area of forested land (kha) | CARBON STOCK CHANGE FACTOR (t C/ha) |                            |                        |                       | TOTAL NET CO <sub>2</sub> EMISSIONS/ REMOVALS (ktCO <sub>2</sub> ) |
|----------|-----------------------------------|-------------------------------------|----------------------------|------------------------|-----------------------|--------------------------------------------------------------------|
|          |                                   | LB                                  | DW                         | LIT                    | SOC                   |                                                                    |
| CROATIA  | 2,354.83                          | 0.3215<br>( <b>0.6194</b> )         | <b>-0.0046</b><br>(NA)     | <b>-0.0168</b><br>(NA) | <b>0.0055</b><br>(NA) | -5,211.12<br>-5,348.40                                             |
| SLOVAKIA | 1,998.59                          | 0.362<br>( <b>0.8295</b> )          | -0.0248<br>( <b>0.08</b> ) | <b>0.003</b><br>(NA)   | <b>0.0119</b><br>(NA) | -6,773.97<br>-6,664.78                                             |

Table 1. Country-specific C stock change factors for deadwood (DW), litter (LIT) and soil (SOC) under *Forest land* remaining *Forest land* subcategory of the LULUCF sector, in grey – values for 2022 published in country NID CRT (2024), in black – simulated values, bold and underlined – values used for calculation of total net CO<sub>2</sub> emissions/removals with conversion factor of 3.667 for ktC to ktCO<sub>2</sub>.