Peat soil thickness and carbon storage in the Belgian High Fens: insights from multi-sensor UAV remote sensing

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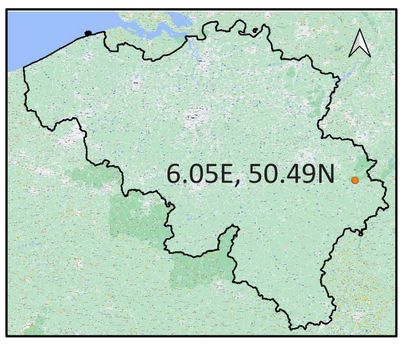
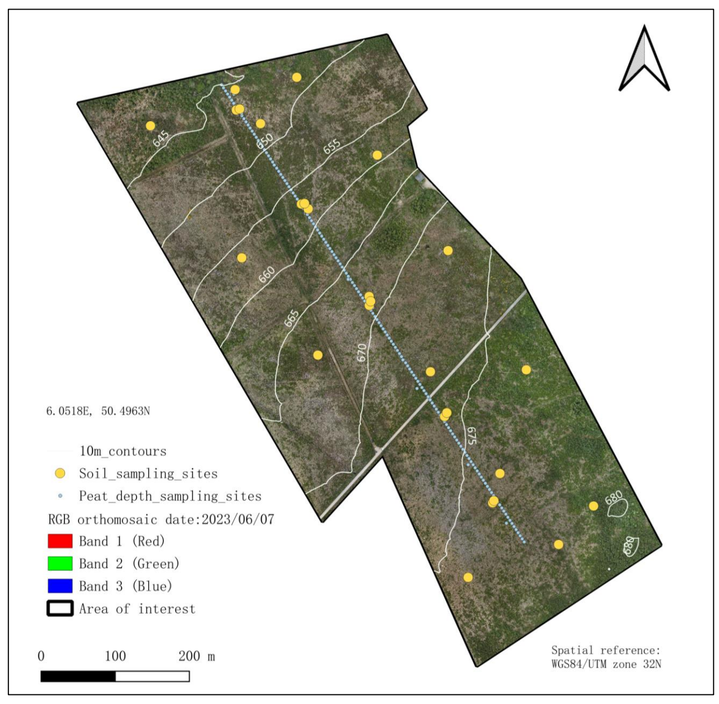
INTRODUCTION

- Peatlands are known to store a large amount of carbon stock.
- Global warming and associated changes in hydrology have the potential to accelerate peatland carbon emissions
- Peat depth and carbon stock are spatially variable across a peatland landscape even at small scales.
- There are now new methods (i.e., GPR, UAVs) based on digital soil mapping and/or remote-sensing tools for collecting high-resolution data, thereby providing new opportunities for achieving accurate peat depth and carbon storage estimates.

STUDY SITE

- A peatland landscape located in Belgian High Fens.
- Steep topographic gradient.

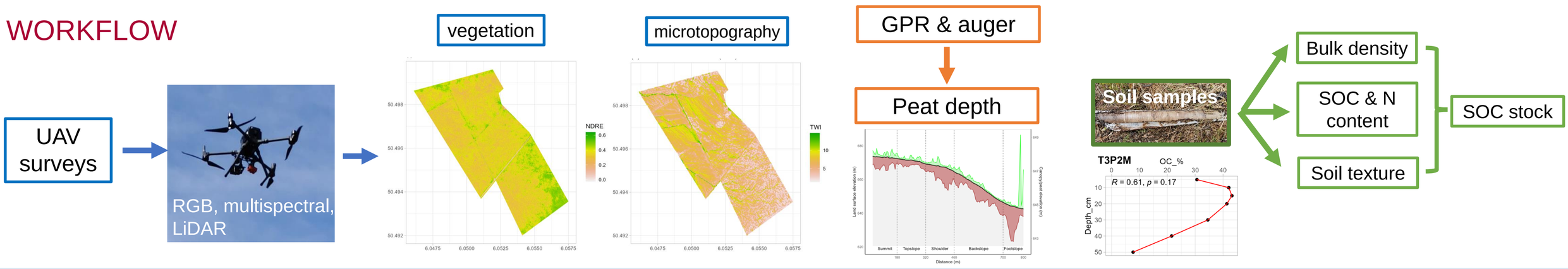




OBJECTIVES

- ➢ Characterizing the spatial and vertical distribution of peat thickness and carbon stock.
- ➢ Identifying factors that control carbon storage, with a specific focus on connections between surface and subsurface.
- ➢ Spatial mapping by UAV data.

WORKFLOW



Results 1: Peat depth & SOC stock spatial distribution

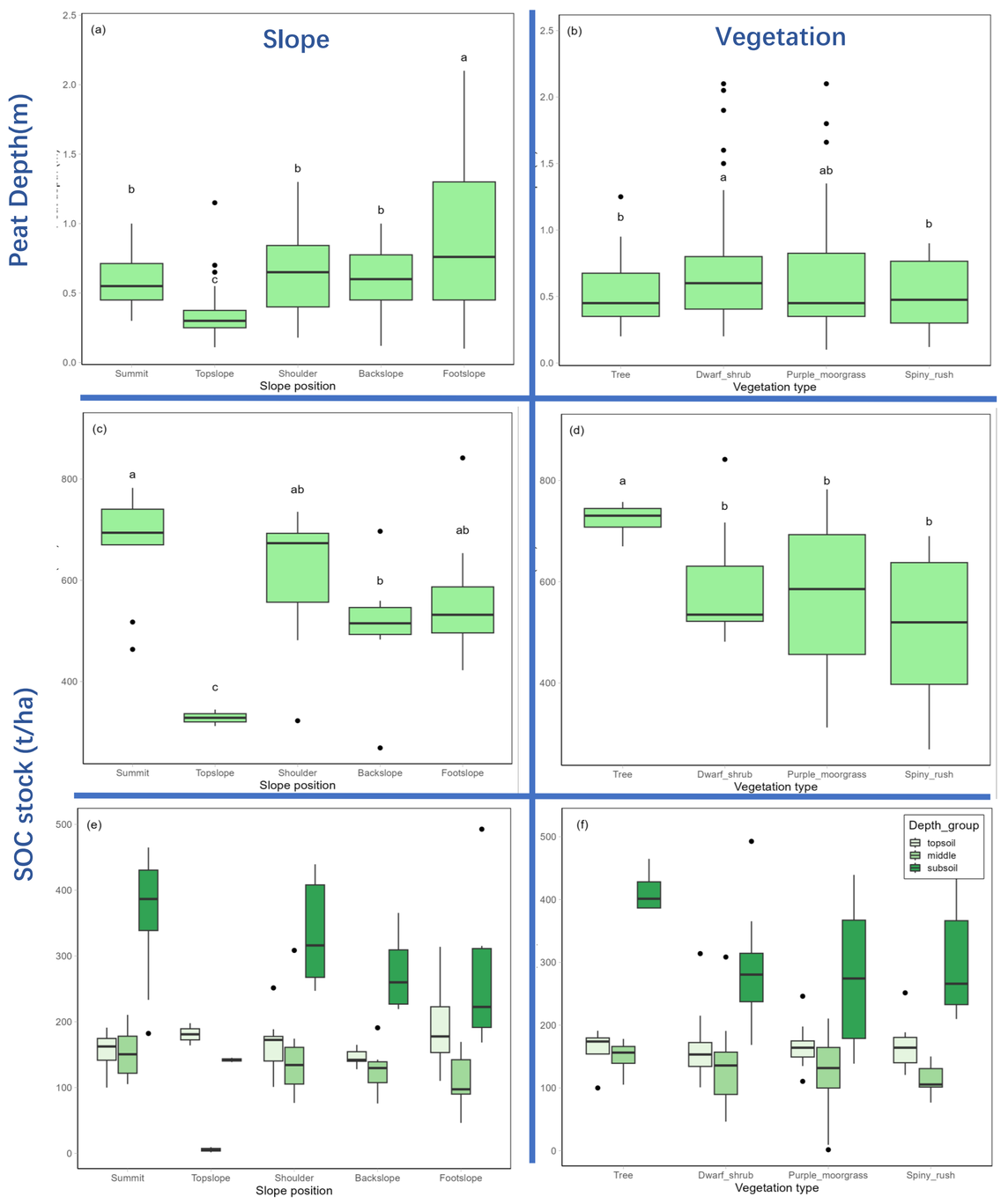


Figure 1. The peat depth (n = 190) and the SOC stock (top 1 m, n = 35) of different slope positions (a) (c) and different vegetation types (b) (d). T-tests were conducted within each class with boxes of the same letters indicating no significant difference in the peat depth and SOC stock. Figures (e) and (f) present the SOC stock depth distribution under different scenarios. The soil depth is classified into 3 groups: topsoil (0~20 cm), middle (~20-40 cm), and subsoil (~40-100 cm).

Conclusions:

- ➢ Topslope: smallest C stock (shallow peat depth, low SOC(7%), very high clay content (23%).
- ➢ Footslope: deepest peat, high SOC (26%), but small bulk density.
- ➢ Backslope: relatively small SOC (19%), erosion (steep slope).
- ➢ Shoulder: flat terrain.
- ➢ Summit: largest C stock (Tree, less degradation).

Results 2: Contribution of environmental factors

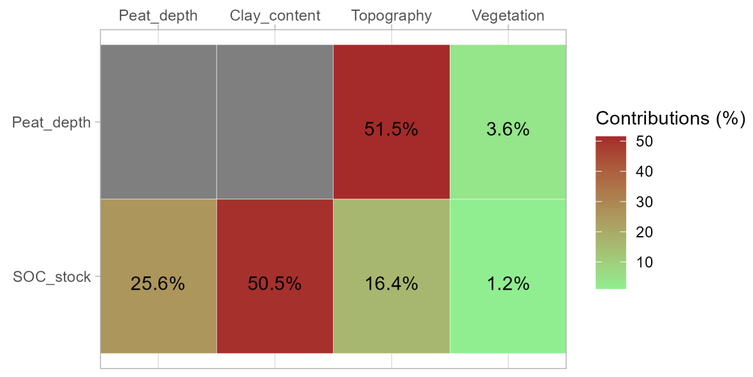


Figure 2. Variable relative contributions for peat depth multiple linear regression model and C stock model. The covariates considered in the peat depth model were peat base elevation, slope, TWI, aspect, cross-section curvature, tangential curvature, NDRE, and sdCHM. The covariates considered in the SOC stock prediction were clay content, elevation, plan curvature, and NDRE.

Conclusions:

Peat depth:

- ➢ Topography controls peat depth, accounting for more than 50%.
- ➢ Vegetation: less important

SOC stock:

- ➢ Clay content has the largest predictive power (over 50%) for C stock.
- ➢ Terrain attributes (elevation and curvature): moderately important.
- ➢ Vegetation: limited contributions.

Results 3: Spatial mapping

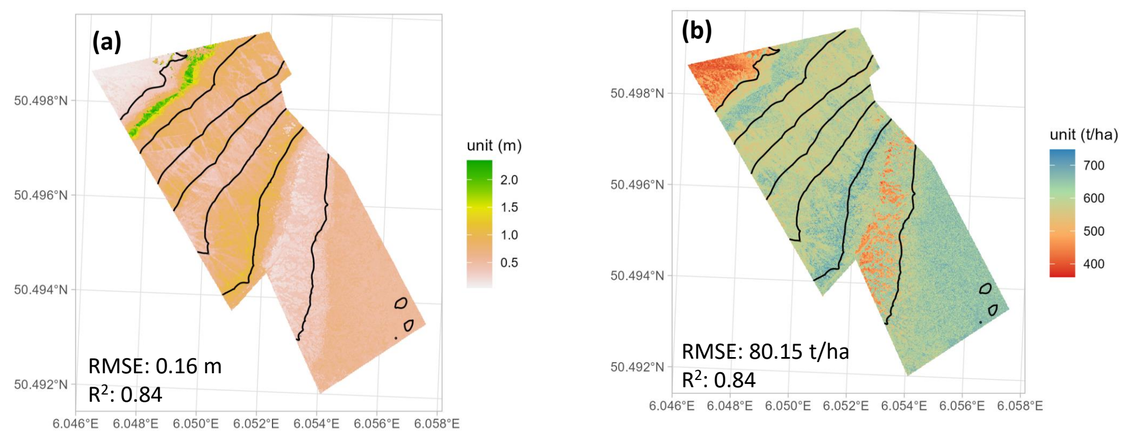


Figure 3. Spatial patterns of predicted peat depth (a) by the Cubist model using both topography and vegetation variables as predictors and spatial patterns of predicted SOC stock (b) by the Random Forest model using peat depth, topography, and vegetation variables as predictors. The black line in the map indicates contours.

Conclusions:

- ➢ Floodplain (northwest): very shallow peat soil and less C stock (the influence of the river).
- ➢ Two deep peat layers located in the footslope and the shoulder.
- ➢ Higher C stock occurs in deep peat areas and the summit.
- ➢ UAVs have great potential in achieving accurate peat depth and SOC stock estimates.