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Fine root and aboveground carbon stocks of recent and diked floodplain forests in Austria - What are the main drivers?

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Background and Aims

Floodplain fulfill important ecosystem functions such as Carbon (C) storage. C stocks of riparian forests are increased compared to uphill forests[1] and extremely variable along different environmental parameters[2,3]. At the same time, C sink function is influenced by human activities[4] such as agriculture or water engineering measures. The underlying mechanisms of C stock distribution are of great interest to this research.

Therefore, it is our aim (1) to quantify C stocks of fine roots (FR) and aboveground biomass (ABG) for total floodplain forest (TFF), recent floodplain forest (RFF) and diked floodplain forest (DFF) (2) to evaluate if there are significant differences between RFF and DFF, and (3) to model C stocks of fine roots and aboveground biomas in response of dike construction, spatial, and forest stand parameters.

Study area

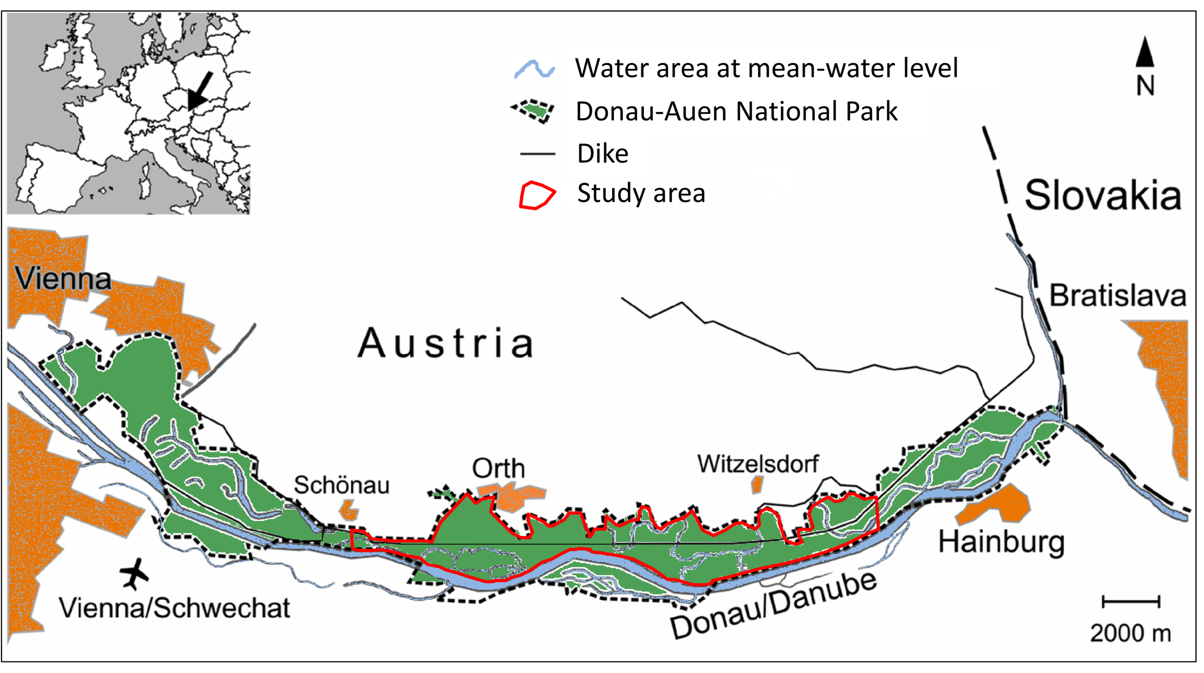

Fig. 1. Study area.

The study area is part of the Donau-Auen National Park in Austria, located between the european capitals Vienna and Bratislava (Fig. 1). The National Park preserves the largest remaining floodplain forest of Central Europe. Dike construction seperates floodplain forests into RFF, characterized by a free water discharge accompanied with hydrogeomorphological dynamics, and DFF protected from surface flooding.

Materials and Methods

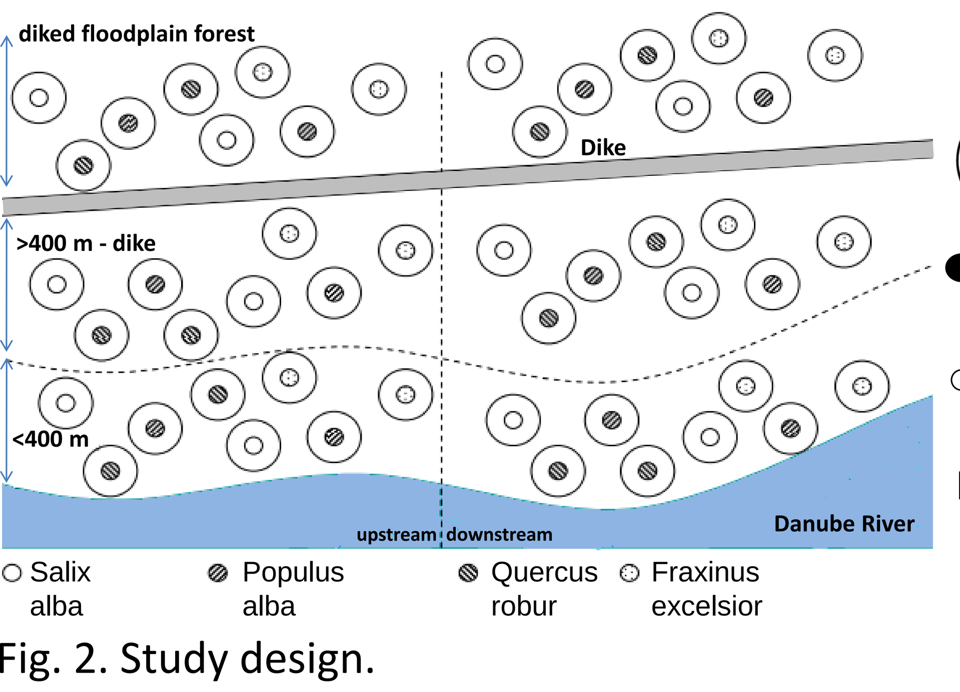

Fig. 2. Study design.

The survey area was stratified into six zones along the longitudinal and lateral gradients (Fig. 2). Within six zones, we selected 48 study trees out of the dominant four trees species in the area. For each tree, spatial parameters were determined by a handheld gps and ArcMap 9.2. We used the angle count sampling method for vegetation analysis. One soil core of the uppermost 30 cm soil was extracted, washed, sieved, categorized (root size and phenology) and weighted to determine C stock of fine roots <3 mm in diameter. Differences among C stocks were tested using Kruskal-Wallis and Welch Two Sample t-test. We used BRT models to detect main drivers of C stocks in fine root and aboveground biomass. All calculations were performed with R version 2.10.0.

Results

Tab. 1. C stock of fine roots by size class and phenology (BM = biomass, NM = necromass).

Size class [mm]	Phenology class	Mean (SE) [t ha^{-1}]
<0.5	BM + NM	1.17 (0.07)
>0.5-1.5	BM + NM	1.16 (0.09)
>1.5 - 3	BM + NM	0.12 (0.04)
>3	BM + NM	0.38 (0.08)
	BM	1.57 (0.24)
Total	NM	1.25 (0.19)
Total	BM + NM	**2.82 (0.29)**

The overall mean C stock of fine roots was about 2.8 t ha^{-1} (Tab. 1). 82% of the total C stock was related to root size <1.5 mm, shared equally by fine root biomass and necromass pool.

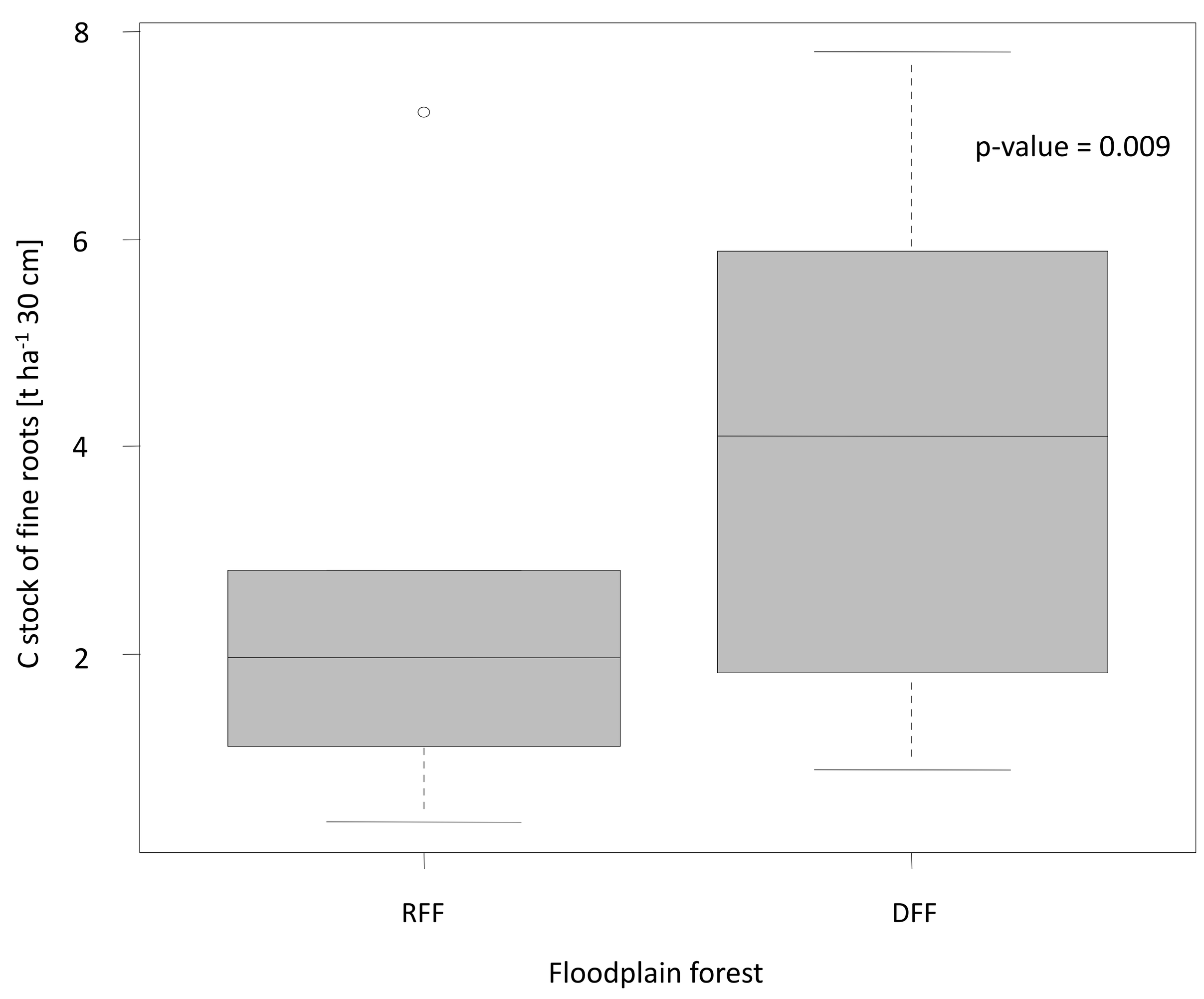

Fig. 3. C stocks of fine roots in recent (RFF) and diked (DFF) floodplain forest.

Mean C stocks of fine roots were significant higher in diked floodplain forest compared to recent floodplain forest (Fig. 3). Significant more dead fine roots were found in DFF for size class >3 mm (0.3 vs. 0.0 t ha^{-1}) and total fine root necromass (2.0 vs. 0.9 t ha^{-1}) then in RFF.

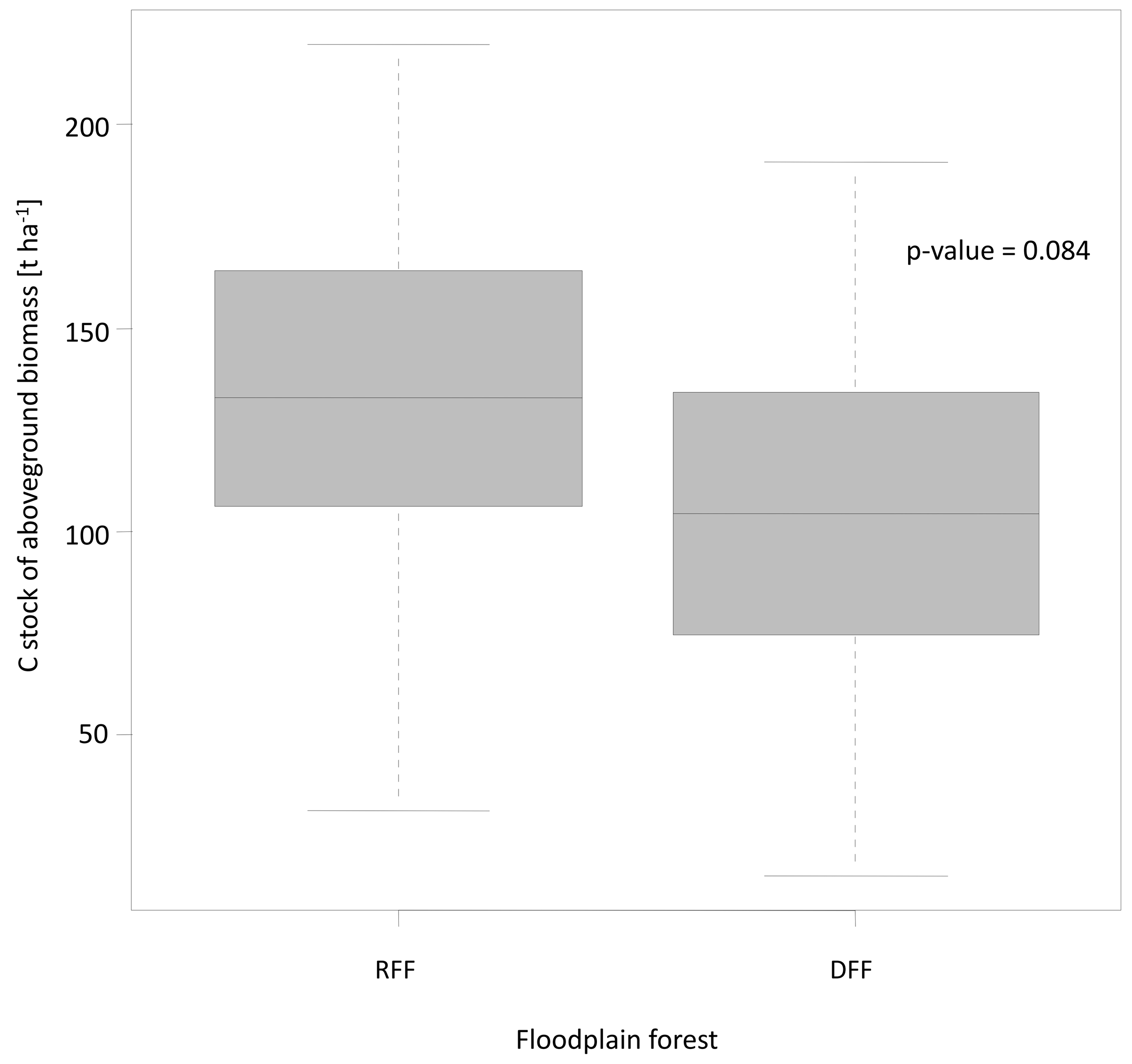

Fig. 4. C stocks of aboveground biomass in RFF and DFF.

Calculated C stock of ABG in TFF including standing biomass, standing deadwood and lying deadwood was 123 t ha^{-1} in average. In contrast to fine roots, mean C stocks of ABG (Fig. 4) were marginally significant higher in RFF (132 t ha^{-1}) compared to DFF (106 t ha^{-1}).

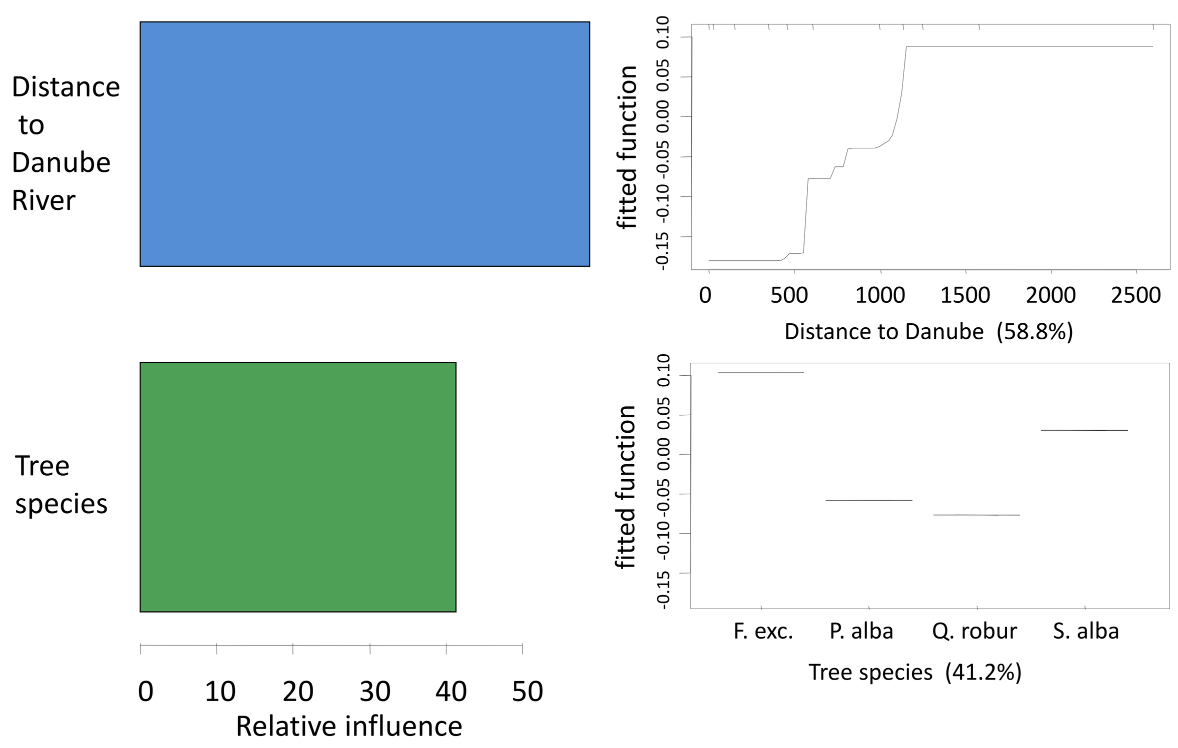

Fig. 5. Main drivers of FR and partial response plots.

Our BRT model of overall C stock for fine roots explained 23% of the variation in the dependent variable. The two most influential drivers of C stocks in fine roots were “Distance to Danube River” and “Tree species” which accounted for 59 and 41% of the explained variance (Fig. 5). Dike was ruled out as predictor variable.

The pattern of the fitted functions indicate that above average C stock of fine roots were located about 600 m away from the Danube River and are found in forest stands dominated by *Fraxinus excelsior* and *Salix alba (Fig. 5)*.

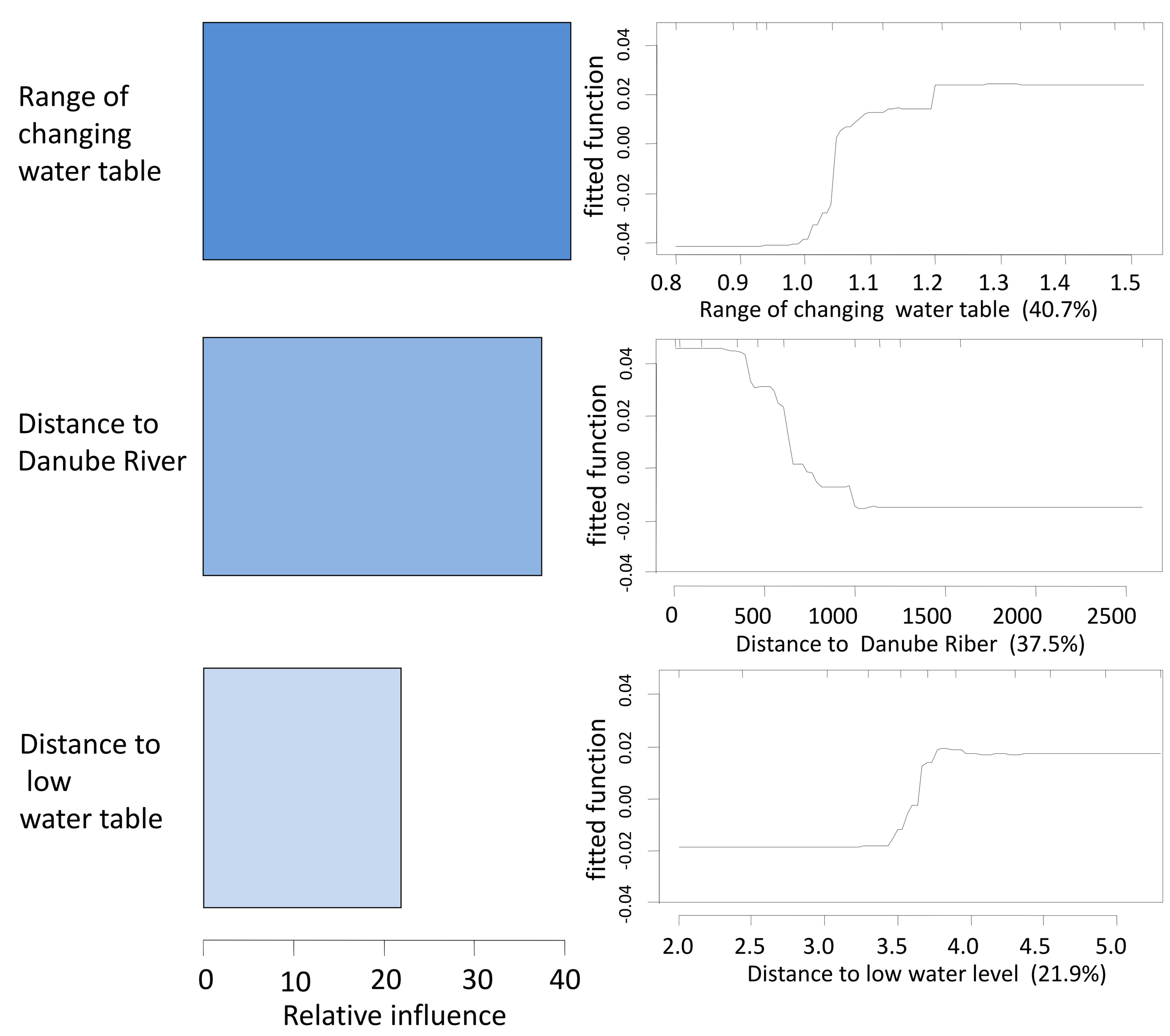

Fig. 6. Main drivers of AGB and partial response plots.

Our BRT model of C stock of aboveground biomass explained 10% of the variation. C stocks were determined by spatial gradients only (Fig. 6).

According to the fitted functions, above average C stocks of aboveground biomass were located beyond 1 m range of changing water table and 3.7 m distance to low water table. In contrast to C stocks of fine roots, highest C stocks of aboveground biomass were found within 500 m distance to Danube River (Fig. 6).

Conclusions

- Dike construction does not directly influence C stocks of fine root and aboveground biomass, but cuts off hydrological extremes of the floodplain
- Surface flooding might play a less important role than depth of water table and the amplitude of changing water tables
- C stocks are mainly influenced by a lateral gradient and tree species traits which are valuable indicators to assess water table regime in floodplain soils
- C stocks of aboveground biomass are negatively related to belowground biomass

References:
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