Nutrient pools in Oak forests as a decision support for harvesting intensities (Biomass potential)

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Introduction

There is growing interest in exploring the potential of woody biomass as a source of renewable, sustainable energy in Northeastern Austria's forests. A fundamental question is how mineral nutrition is affected by harvesting biomass. Losses of plant nutrients exceeding the natural replenishment due to deposition and weathering will ultimately lead to declining growth rates. This study focused on mineral nutrient pool characteristics in deciduous forests in order to investigate the effects of stand age and soil type on exchangeable cations as a basis for sustainable forest management in *Quercus* dominated forests in northeastern Austria.

Methods

Nine permanent *Quercus petraea* dominated plots (Fig 1, Tab 1) were selected for our study. Soil pH, nitrogen and the exchangeable mineral elements K, Ca, Mg, Na, Mn, Al, and Fe were determined in five (0-5 cm, 5-10 cm, 10-20 cm, 20-40cm, 40-50cm) geometric soil horizons. Inventory of aboveground biomass was performed.

Fig 1 Landscape of study area

Table 1 Description of the selected study plots

Plot number	Quercus Stand age (year)	Plot size (m)	Species composition	Soil types
S1	11	40*40	*Quercus petraea* with few *Rubus fruticosus*	Eutric cambisol (coarse material ≤ 40%)
S2	32	40*40	*Quercus petraea* with *Galium sylvaticum* in the understory	
S3	50	40*40	*Quercus petraea* with few *Corylus avellana*	
S4	74	40*40	*Quercus petraea* and *Carpinus betulus* with *Galium sylvaticum* in the understory	
S5	91	50*50	*Quercus petraea* with few *Corylus avellana*	
L2	31	40*40	*Quercus petraea* with few *Acer campestre, Betula pendula, Cornus sanguinea*	Calcic chernozem
L3	43	40*40	*Quercus petraea* with few young *Corylus avellana*	Haplic luvisol (coarse material ≤ 20%)
L4	73	40*40	*Quercus petraea* with few *Corylus avellana*	
L5	82	50*50	*Quercus petraea* with young *Carpinus betulus* and *Galium sylvaticum* in the understory	

Results

In our study area, nutrient pools at soil depth 0-50 cm were (kg/ha): N 3640 – 7210, K 883 - 1510, Ca 1630 – 13630, Al 66 - 1656, Mg 322 - 1848, Fe 0 - 30 and Mn 85 - 399. Base cations are key factors controlling nitrogen retention and release of forest ecosystems. Generally high acid cation content corresponded to low base cations and vice versa (Fig 2). CEC ranged from 34 to 189 µmol/g in the entire research area and was significantly positively correlated (Pearson correlation coefficient 0.661, $P<0.01$) with the soil pH (H_2O). Fig 3 shows that mineral soil has sufficient nutrient pools to support potential by increased harvesting of aboveground biomass.

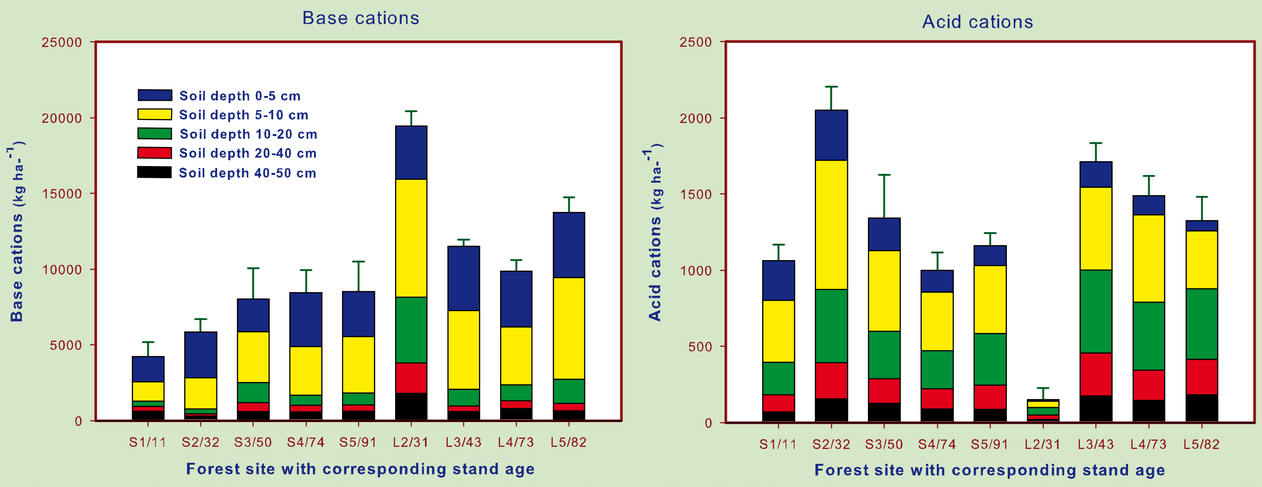

Fig 2 Pools of base cations and acid cations (kg/ha) in the top 50 cm of the forest soil in our study area. Mean values (n=9) and standard error bars.

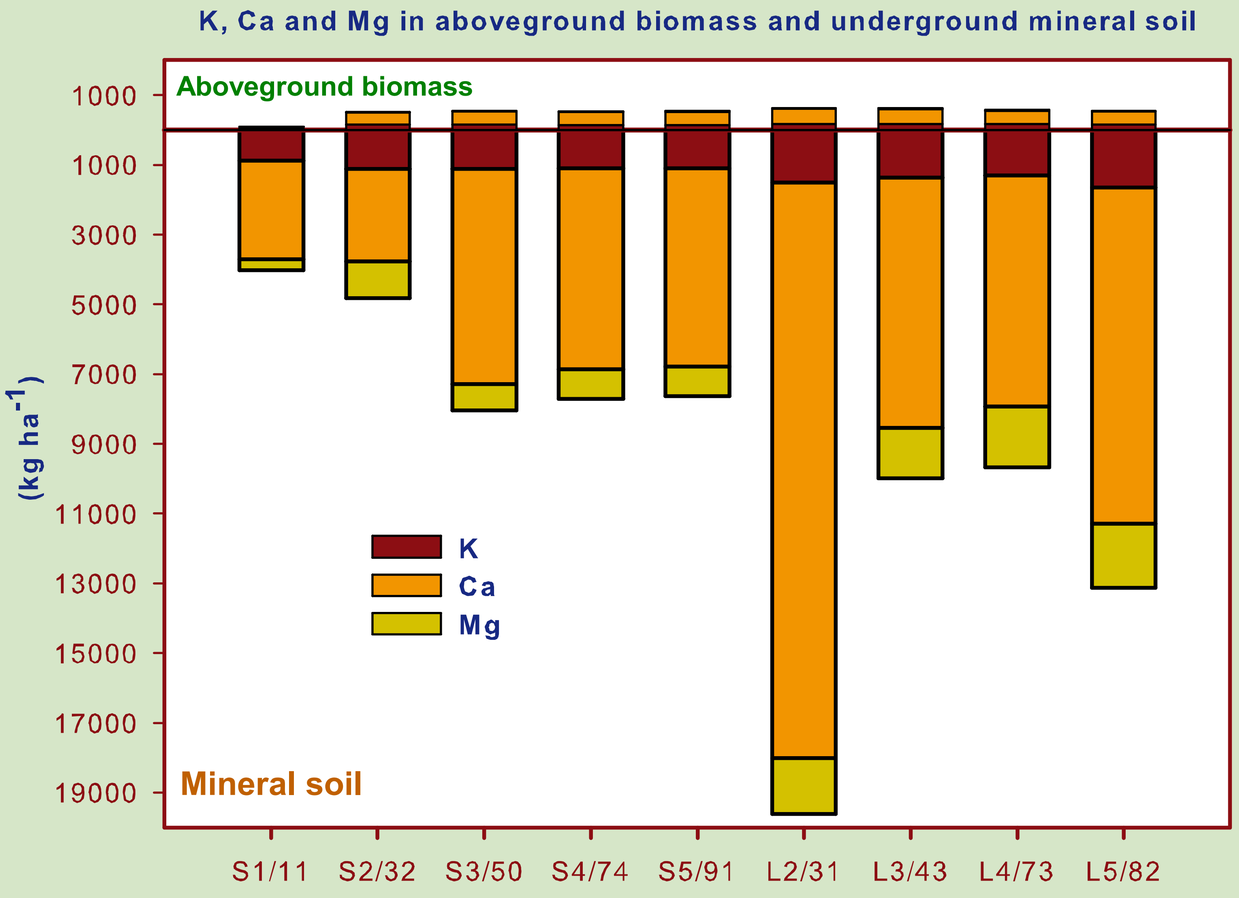

Fig 3 Comparison of estimated nutrients pools of K, Ca and Mg (kg/ha) in aboveground biomass and exchangeable K, Ca and Mg in underground 50 cm mineral soils.

Conclusion

In our study stand age has no large influence on nutrient pools. Soil type, soil depth and soil pH were the most important factors to influence the nutrients and CEC. At current biomass extraction levels the investigated deciduous forests in northeastern Austria can be managed both for timber or, if the market permits, for biomass used as energy source.