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Impact of forest stand management on temporal dynamics of soil carbon and nitrogen

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The quantity and quality of soil organic matter (SOM) strongly influence the biomass production capacity of forest ecosystems. At present, increased biomass harvesting for energetic utilisation is a hot topic. The extraction of logging residues, which are left on site in traditional forest management in Austria, and shortening of rotation periods will potentially alter carbon (C) and nitrogen (N) mineralization rates and turnover. This study focuses on i) assessing the influence of different forest management systems for deciduous species on soil C- and N stores and mineralization potential along a full rotation period and ii) testing whether silvicultural systems can be used to manage N retention and release. The chronosequence approach was used to study temporal dynamics of C and N on differently managed, *Quercus petraea* dominated forest sites (high forest on eutric cambisol, 11-91years as well as coppice with standards system on haplic chernozem, 1-50years). Above- and belowground biomass pools as well as belowground organic C- and total N pools (in five geometric horizons, up to 50cm depth) were estimated by means of systematic sampling of the soil and use of allometric functions for biomass pools. C was determined by dry combustion (soil organic carbon (SOC) and N by Kieldahl digestion (soil total N). SOC pools ranged from 5.3 to 6.9kg.m^{-2} on eutric cambisol, representing 43% of total site C stores and from 7.2 to 10.4kg.m^{-2} on haplic chernozem, representing 42% respectively. Total N stores in the mineral soil compartment ranged from 0.36 to 0.45kg.m^{-2} and from 0.65 to 0.94kg.m^{-2} for the two soil types. No significant correlation with stand age was observed for C and N pools in both study areas. However, C/N ratios as a measure for nitrogen availability show distinct temporal trends along the chronosequence in differently managed stands. The high forest system shows a gradual decrease of C/N ratio with increasing stand age in all horizons while the coppice with standards system shows a decrease until about half of the rotation period after which it increases again to the end of the rotation period. Wide C/N ratios at the beginning of rotation periods indicate rapid mineralization rates after harvesting. In the high forest on eutric cambisol sites, the C/N ratio is predominantly correlated with C (Pearson correlation coefficient of R=+0.70, $p<0.01$) in contrast to N (R=+0.17, $p<0.01$). Conversely, the C/N ratio in the coppice with standards on haplic chernozem is predominantly correlated with N (R=-0.33, $p<0.01$) in contrast to C (R=+0.20, $p<0.01$). A general trend of higher C/N ratios in the high forest indicates higher accumulation rates for C than for N. C/N ratios around 30-35 (<20 in mineral soil) indicate rapid litter decomposition under both silviculture regimes. The ratio between aboveground (living biomass, litter) and belowground carbon pools (SOC, roots, decay) generally increases with rising age and is always higher in coppice with standards system due to remaining standards after harvesting. This effect offsets nearly 10 years of stand development in the high forest system. We were able to identify clear patterns of C- and N dynamics resulting from different management regimes in different soil types on our study sites. The retention and release of nitrogen could be regulated by appropriate silvicultural systems, which should be considered when increased biomass extraction for energetic use becomes the management goal.

Keywords: SOC, C/N ratio, mineralization, forest management, *Quercus.*