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Do tree species affect decadal changes in topsoil pH and C and N stocks? - Resampling of soils in the Danish broadleaved common garden experiment

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Several studies revealed tree species related differences in topsoil pH and topsoil stocks of organic C (C_{org}) and total nitrogen (N_t). However, to the best of our knowledge, the species effect on the rate of change in these properties has not been assessed in common garden experiments by repeated sampling. We aimed at quantifying possible tree species effects on decadal changes in soil properties. In 2015/2016, i.e. 11 years after the first sampling, we resampled the topsoil (0-5 cm, 5-15 cm, 15-30 cm) under six European tree species (beech - *Fagus sylvatica* L., pedunculate oak - *Quercus robur* L., lime - *Tilia cordata* L., sycamore maple - *Acer pseudoplatanus* L., ash - *Fraxinus excelsior* L. and Norway spruce - *Picea abies* (L.) Karst.) in six common garden experimental sites (planted in 1973 and 1961) located across Denmark.

In 0-5 cm depth, soil pH varied between 3.1 and 5.1 and was lower under spruce than ash, lime and maple across all sites. During the past decade, acidification dominated in all species and there was no general species effect on pH change. Instead site conditions, such as clay content and parent material, determined the acidification strength of the individual tree species. For example, at a sandy, acidic site, the strongest decrease in pH occurred under ash (0-5 cm: -0.45 pH-units). In contrast, at a site with a base-rich soil (almost neutral pH below 30 cm soil depth), pH increased in lime (0-30 cm soil depth), maple (5-15 cm soil depth) and ash (5-30 cm soil depth). Thus, these species might function as base pumps at this site that had beech forest as former land-use.

Across all sites, C_{org} and N_t stocks did not differ significantly between species. Decadal change of C_{org} stocks in 0-30 cm depths varied between a loss of C_{org} of ~20 Mg ha^{-1} and an increase of ~10 Mg ha^{-1}, independent of the species. In 5-15 cm depth, species affected C_{org}stock changes independent of site. Ash (-6.2±5.0 Mg ha^{-1} decade^{-1}) and oak (-5.9±4.1 Mg ha^{-1} decade^{-1}) showed the highest loss of soil C_{org}, while C_{org} stocks in lime (-2.8±7.1 Mg ha^{-1} decade^{-1}) remained more or less stable. No differences in N_t stock changes (slight loss of N dominated) between species occurred. C_{org}:N_t ratio was lowest under ash and maple and highest under spruce. The C_{org}:N_t ratio did not change significantly over the past decade as changes in C_{org} and N_t stocks were highly correlated (R^2=0.88).

In conclusion, after one decade, we found few tree species-specific changes in soil pH as well as in C_{org} stocks. Certain changes seemed to relate on site conditions, such as clay content or parent material, e.g. the suggested base pump effect at the site with base-rich parent material. Results from this resampling study suggest that after only one decade, small tree-species specific changes do occur in pH and soil C stocks despite the huge reservoir of C and protons in the soil. Further, these changes seem mainly context-dependent.