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$\delta^{15}N$ in soil profiles of differently managed temperate forest stands

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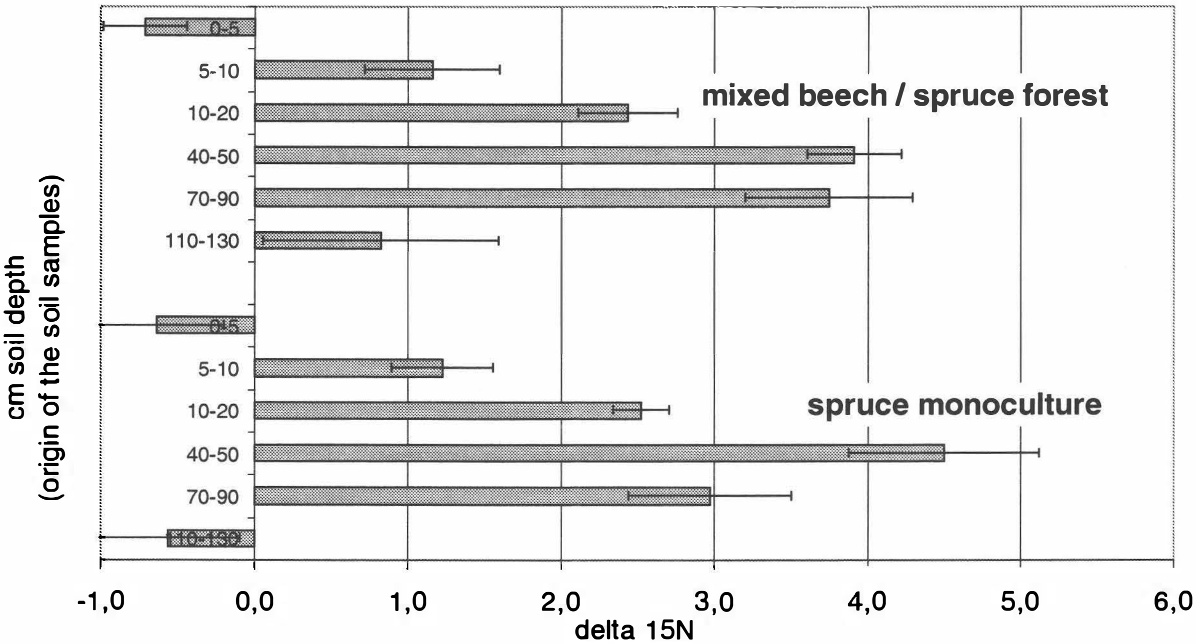
Since the 19th century it became increasingly popular to plant Norway spruce (*Picea abies*) outside its climatic range. In areas, where the natural climax vegetation would comprise mixed broadleaf forests with high abundance of beech (*Fagus sylvestris*), large areas are covered by spruce monocultures now.

This work is part of a project, that aims to characterize and compare spruce monocultures with mixed beech/spruce forests in close-by locations, where similar geology and climate can be expected. The goals of the project are i) the evaluation of the impact of forest management (mixed forest vs. monoculture) on nutrient cycling (improvement of the theoretical basis), ii) modelling and predicting effects of forest management on soil processes and nutrient fluxes, and iii) distinguishing pathways of nutrient turnover in these two types of forest management by means of natural abundance measurements of stable isotopes (C, N, O, Sr). On one hand, the sampling locations were chosen in the geological Flysh zone (sandstone formation) of Upper and Lower Austria. The natural forest vegetation of this area is classified as *Asperulo odoratae-Fagetum.* Secondly, locations were selected in the Molasse region, north of the Alps in the so-called Kobernausser Forest, Upper Austria. Natural forest vegetation is *Luzulo nemorosae-Fagetum.* The Molasse sites are characterized by lower pHs (2,6 – 3,4; $CaCl_2$) compared to the Flysh sites (3,1 – 5,5); these sites are more sandy and exhibit a lower nutrient availability. All sites include forests of different stand age (sapling, pole, mature).

On Flysh, spruce monocultures caused distinct top soil acidification due to sequestration of basic cations in the canopy and O-horizon. At low pH (Molasse sites) this effect was not visible which is most likely not only the consequence of the logarithmic pH-scale but also the consequence of low base content, which does not allow for distribution of large amounts of base cations. Soil profiles were taken to measure the vertical distribution of stable nitrogen isotopes. In the upper soil layers (0-5 cm), negative $\delta^{15}N$ values indicate that depleted plant material was deposited and incorporated after decomposition into the topsoil. ^{15}N is discriminated in several steps during mineralization of organic material and uptake and assimilation of mineral N by plants, corresponding to commonly ^{15}N-depleted plant litter.

Nitrogen isotopes in different soil layers of mixed beech/spruce forest and spruce monoculture on molasse sites in Upper Austria (mean and standard error, n=6)



On Flysh, no major differences in soil $\delta^{15}N$ values could be found between mixed forests and monocultures. On Molasse, however, there were marked differences between both types of forest management (see Figure): monoculture caused more positive $\delta^{15}N$ values in middle soil strata (40-70 cm depth), but much lower or even negative $\delta^{15}N$ values in deeper soil layers (below 100 cm). The high $\delta^{15}N$ values of middle soil layers could be due to the strong ^{15}N discrimination during ammonium oxidation to nitrate (nitrification), resulting in ^{15}N-depleted nitrate and the remaining ammonium pool becoming ^{15}N-enriched. Nitrate can be further metabolized under wet conditions into gaseous nitrogen (oxides) by denitrifying microorganisms, leaving the soil thereafter. Denitrification also exhibits a significant isotope effect. On the other hand, nitrate may have been leached into deeper soil layers, where consequently $\delta^{15}N$ values became more negative if nitrate was biologically or physico-chemically retained from percolating soil solution. However, it remains to be elucidated if the ^{15}N-depleted deep soil layers, which were only detected in spruce monocultures but not in mixed forests of the Molasse zone, were related to nitrate loss.

In conclusion, the nitrogen isotope measurements clearly indicated that on the Molasse sites, spruce monoculture resulted in distinct changes in the soil N dynamics. On Flysh sites strong shifts were observed only in soil pH, but not in N isotope composition.

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