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Interrelations between foliar nutrient imbalances and forest growth

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Foliar phosphorus (P) and nitrogen (N) concentrations serve as indicators for the nutritional state of forest trees and their productive capacities. Concerns have been raised that primary production in forest ecosystems is increasingly limited by P supply due to changing environmental conditions, such as increased atmospheric CO_2 concentration, changes in weather conditions and longer growth periods, as well as atmospheric nitrogen deposition, which all favour tree growth.

Intensive monitoring sites of the German Federal States and the UNECE ICP Forests Programme (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) offer extensive data sets allowing the study of foliar nutrients and forest growth across gradients in atmospheric deposition as well as climatic and soil conditions for different tree species. Additionally, tree ring measurements from German intensive monitoring plots were used in this study.

Across Europe, both P and N concentrations in leaves and needles have been decreasing at significant rates over the past thirty years. As the decrease of P concentrations (5.7 % over 10 years) is steeper than the decrease of N concentrations (2.6 % over 10 years), a shift from N limitation to P limitation is believed to have occurred in many forest ecosystems. More than half of broadleaf forest plots within the ICP Forests Programme are above the critical N/P ratio, indicating P deficiency.

Beyond long-term trends, foliar nutrient concentrations show inter-annual variability that can be predicted through current and lagged weather conditions, with spring and summer temperature generally producing better predictions than precipitation. Study of European beech and Norway spruce on German ICP Forests intensive monitoring plots showed no general links between fluctuations in nutrient concentrations and in radial stem increments. Patterns in parallel or opposite fluctuations were identified and links with soil conditions tested. Results will improve our understanding of the ecological and economic implications of nutrient imbalances on forest growth.