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Soil properties and nutrient cycling in the alpine treeline ecotone of Rolwaling Himal, Nepal

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At a global scale, low-temperature growth limitation determines the position of natural alpine treelines. At landscape and local scales, however, treeline position, form (spatial pattern), and dynamics depend on multiple interactions of influencing factors and mechanisms. The aim of our research is to understand these large-scale effects of soil properties and nutrient cycling on tree growth limitation, and their interactions with other abiotic and biotic factors, in the alpine treeline ecotone of Rolwaling Himal, Nepal. In total 48 plots (20m x 20m) were investigated. Three north facing slopes were separated in four different altitudinal zones with the typical vegetation of tree species Rhododendron campanulatum, Abies spectabilis, Betula utilis, Sorbus microphylla and Acer spec. The main pedogenetic process is leaching of soil organic matter, aluminium and iron from topsoil to subsoil. Soil types can be considered as podsols.
Mean growing season soil temperatures (10cm depth) were found to decrease with altitude from closed forest (8-9°C) to krummholz zone (6-7°C) to open tundra vegetation (5-6°C), which is in the range of the 6.7°C threshold temperature under treeline trees at a global scale. Soil moisture measurements (10 cm depth) showed pF values from 0.5 to 1.6. Both, plant-available soil nutrients and leave macronutrient concentrations of nitrogen (N), magnesium (Mg), and potassium (K) decrease with increasing altitude in the treeline ecotone.
With multivariate statistical approaches the potential determining factors of treeline position could be quantified. From that we assume low soil temperatures and malnutrition to strongly affect tree growth at high altitudes. We suppose that at least one of the mentioned macronutrients is likely one of the limiting factors for tree growth at a local scale, whereas water shortage is unlikely to determine tree growth due to sufficient water availability during the entire year.