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Outcomes of a quantitative analysis of 46 soil chronosequence studies: Vegetation plays the key role for rates of podzolization in most environments.

Lisa Zwanzig[1], Martin Zwanzig[2], and Daniela Sauer[3]
[1]Institute of Geography, TU Dresden, Dresden, Germany (lisa.zwanzig@tu-dresden.de)
[2]Institute of Forest Growth and Forest Computer Science, TU Dresden, Tharandt, Germany (martin.zwanzig@tu-dresden.de)
[3]Institute of Geography, University of Göttingen, Göttingen, Germany (daniela.sauer@geo.uni-goettingen.de)

Soil formation is controlled by climate, vegetation, organisms, topography, parent material and time. There are various hypotheses on the relative importance of these individual soil-forming factors. The quantitative influence of each soil-forming factor on the expression and rates of soil-forming processes, and in particular the influence of the different factors in combination, have not yet been sufficiently analyzed. The aim of this study was to quantify the influence of the soil-forming factors on the rates of podzolization. For this purpose, we compiled published data from 46 soil chronosequence studies in a database. These studies contained altogether 231 soil profiles of known age, on which we tested existing hypotheses on the influence of different soil-forming factors. The formation of an E horizon and its increase in thickness over time is one of the characteristic features of Podzol formation. As it is one of the few features that was described in all 46 studies, we used it as an indicator of progressive podzolization. Through statistical analysis, we investigated how E horizon thickness is affected by latitude, longitude, mean annual precipitation, mean annual temperature, range between minimum and maximum monthly temperature, annual number of days with frost, vegetation class (pioneer, deciduous and coniferous), sand content, clay content, and soil age.

Since E horizon thickness exhibited a zero-inflated (semi-)continuous distribution, we opted for a zero-altered gamma (ZAG) model, consisting of a Bernoulli and a Gamma part. The Bernoulli part shows, how the probability of the presence of an E horizon changes with soil age and environmental conditions. The Gamma part of the ZAG model allows for capturing the effects of the covariates on E horizon thickness. Our results indicate that vegetation is the most important factor for both (1) the soil age at which podzolization starts (used indicator: first occurrence of an E horizon), and (2) the rates of podzolization thereafter (used measure: increase of E horizon thickness with soil age). Climatic factors such as mean annual precipitation and range of temperature play subordinate roles. They are important for the soil age at which podzolization starts but less important for the rates of podzolization. We did not identify a significant influence of sand content, neither on the start nor the rates of podzolization. Thus, this statistical assessment of global data provides new insights into the relative importance of the individual soil-forming factors on the onset and temporal course of podzolization.